

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
Energy Efficiency and Renewable Energy
Energy Supply
(Tabular dollars in thousands, Narrative in whole dollars)

Solar and Renewable Energy

EXECUTIVE SUMMARY

Introduction

The programs of the Office of Energy Efficiency and Renewable Energy (EERE) funded by the Energy and Water Development Appropriations Subcommittee are designed to improve the performance and reduce the costs of a broad range of renewable electric, fuel, and related storage and power delivery technologies. Included are programs on alternative transportation fuels, advanced turbine cogeneration, photovoltaics, solar thermal, biomass, geothermal and hydroelectric power systems, hydrogen, energy storage, high temperature superconductivity, potential health effects of exposure to power line frequencies, and utility restructuring. The technologies advanced under these programs will be the building blocks of cleaner, more flexible, energy systems of the future. EERE's programs work in voluntary cost shared partnerships with the nation's utilities, industries, states, and the public to advance the development and deployment of clean and efficient energy technologies. By advancing the research, development, and deployment of energy technologies, EERE's solar and other renewable energy programs diversify sources of electricity and fuel supply, improve the environment, and advance U.S. economic growth and job creation.

In its 1997 review of the national energy R&D portfolio, the President's Committee of Advisors on Science and Technology recommended expansion of a number of national energy R&D programs, including renewable energy programs among the highest priorities for increased funding. The Committee noted that renewable energy technologies produce a number of benefits, including air emission reductions and reduced dependence on imported oil. Crediting DOE with remarkable gains in technology performance and cost reductions, the Committee called for significant expansion of renewable energy R&D programs in order to meet the energy challenges and opportunities of the 21st century.

EXECUTIVE SUMMARY: Solar and Renewable Energy (Cont'd)

EERE's renewable energy programs target Federal resources in key areas that provide critical national benefits; stimulate complementary private investments; leverage market forces; and respond to five significant drivers:

- National Security;
- Economic Competitiveness;
- Environmental Quality;
- Climate Change; and,
- Electric Utility Restructuring.

National Security

During the past 23 years, three major disruptions in the world oil market have shaken the global economy. In 1996, U.S. net oil imports accounted for approximately 45 percent of domestic petroleum consumption. By 2020, U.S. net oil imports are expected to grow to over 65 percent of domestic petroleum consumption, with Persian Gulf nations accounting for over 65 percent of the world's oil exports. In 2020, U.S. net annual expenditures for imported crude oil and products are projected to exceed \$130 billion in current dollars. Given historical precedents and future oil market trends, the United States has a critical interest in diminishing the nation's reliance on foreign oil through improved efficiency and use of indigenous renewable energy sources. EERE's efforts to implement a smart energy policy recognize this security concern and work to reduce U.S. dependence on foreign oil. As a related benefit, EERE's work on efficiency and renewable energy reduces the U.S. trade deficit by reducing costly energy imports.

Economic Competitiveness

In addition to reducing the nation's vulnerability to disruptions in energy supplies, EERE's research and development efforts advance U.S. economic interests. Carried out in partnership with industry, national laboratories, and universities, EERE's research and development programs are designed to maintain America's technological expertise and competitive advantage in the global market. A smart energy policy, as promoted by EERE's programs, strengthens the nation's economic power. EERE's investments not only lay the foundation for a more sustainable energy future but also open markets for manufacturers of advanced U.S. renewable electric and related power sector technologies.

EERE sponsors international programs to promote U.S. renewable energy technologies and services in international markets, to help ensure that U.S. companies are competitive in the large and growing global marketplace. The World Bank has estimated that, over the next four decades, developing countries alone will require five million megawatts of new electrical capacity to meet the needs of their citizens and their expanding economics. (The world's total installed capacity today is three million megawatts.) This demand

EXECUTIVE SUMMARY: Solar and Renewable Energy (Cont'd)

represents a tremendous potential for job creation and technology sales, even if renewable technologies only capture a fraction of the worldwide market. EERE also participates in the Department's Science Education programs to cultivate the next generation of science and technology leaders and ensure the nation's continued economic competitiveness.

Environmental Quality

Air pollution, particularly in urban centers, ranks high among the nation's most pressing environmental concerns. In advancing a smart energy policy, EERE programs work to mitigate and minimize the environmental costs associated with energy use. Renewable technologies offer a cleaner, environmentally responsible option for generating power.

Climate Change

The President's FY 1999 budget request for EERE programs is a major element of his proposal to invest \$5 billion over five years to reduce greenhouse gas emissions to below 1990 levels by 2008 - 2012 through energy technology research and development and tax incentives. In 1997, a major study conducted by five national laboratories documented the critical role that development and deployment of energy efficiency and renewable energy technologies can play in reducing greenhouse gases. Given the cost savings associated with the use of efficiency technologies, the study noted that aggressive investment in energy R&D could lead to significant emission reductions without raising the nation's energy bill. Furthermore, investments in renewable technologies can provide viable alternative energy sources with fewer greenhouse gas emissions. In particular, these technologies can help to meet the expanding energy needs of developing countries.

Electric Utility Restructuring

EERE is working with utilities, industry, states, and consumers to ensure that utility restructuring results in a competitive and effective electricity generation industry. Utility restructuring presents an opportunity to reduce energy costs, advance the use of energy efficient and renewable energy technologies, and provide affordable services with reduced environmental impacts.

Long-Term Priorities

EERE oversees a wide range of research, development, and deployment activities that lead to energy savings, environmental benefits, and carbon emission reductions. The following long-term goals reflect some of EERE's priorities for the renewable energy and related programs, funded by the Energy and Water Development Appropriations Subcommittee:

- Develop alternative fuels that can displace 10 percent of year 2010 projected transportation oil use.

EXECUTIVE SUMMARY: Solar and Renewable Energy (Cont'd)

- Develop a broad range of renewable technologies and supporting policies capable of at least doubling U.S. non-hydroelectric renewable electric generating capacity by 2010.
- Develop advanced energy storage, power generation, and delivery technologies that build upon recent advances in high temperature superconductivity.
- Advance the state of various energy storage technologies that can facilitate the integration of intermittent renewable power generation into the electricity supply system.
- Develop hydrogen production, storage, and utilization systems that provide the basis for eventual widespread use of this flexible and environmentally benign energy carrier.
- Develop advanced turbine cogeneration systems that allow more efficient and cost effective use of gaseous fuels.

Using Federal Resources Wisely: Maximizing Public Benefit

EERE has developed expertise in setting program goals, measuring performance, and defining budget priorities based on projected benefits. EERE also works closely with industry to set research goals and leverage private sector resources. In an effort to build on these practices, EERE is adopting the following management principles to ensure that its research, development, and deployment programs invest resources effectively and efficiently and achieve the greatest public benefit.

- *Competitive Solicitations:* EERE is increasing the amount of its program funds that will be awarded competitively. By issuing competitive solicitations, EERE will be able to evaluate and compare proposals and fund the most promising technologies. A number of EERE programs will issue broad solicitations in order to select among a wide range of technologies, rather than narrowly investing in each industry. This type of competitive process will lead to more effective use of R&D funds.
- *Performance Measurement:* As noted above, EERE assesses the progress of its programs against defined criteria. In particular, EERE projects the energy displaced, cost savings, and carbon reductions associated with its programs. EERE will continue to measure performance of its programs and quantify associated benefits. As a related effort, EERE will continue to use peer review to help evaluate programs and set priorities.

EXECUTIVE SUMMARY: Solar and Renewable Energy (Cont'd)

- *Project Termination:* As part of EERE's commitment to investing resources efficiently, EERE will discontinue projects that do not meet pre-determined goals. EERE also recognizes the need to define project schedules and work toward completion.
- *Coordination of Cross-Cutting Activities:* EERE's sector programs work on a number of related projects that serve the interests of multiple customers. Furthermore, EERE represents only one part of public and private investment in energy technologies. The Department of Energy's Offices of Fossil Energy, Nuclear Energy, and Energy Research, along with other Federal agencies, are involved in complementary research. EERE is committed to working closely with its public and private sector partners to avoid redundancy and direct R&D to achieve the greatest public benefit.
- *Improved Deployment through Support Offices:* EERE's sector programs rely on regional support offices to implement a number of important activities. RSOs collaborate with regional interests and ensure that EERE programs and technologies are deployed at the state and local level.
- *Clearer Budgeting:* As the FY 1999 budget illustrates, EERE is working to clarify how funds are used across sectors and in the regional support offices. In particular, EERE is requesting specific increases in the program direction account for cross-cutting activities that were formerly funded through directed funding from sector program accounts.
- *Reductions in Uncosted Balances:* Since the beginning of FY 1996, EERE has reduced its uncosted balances by over 40 percent. EERE is committed to managing and investing its resources wisely, and will continue to work to lower remaining balances.
- *Collaboration with Customers:* EERE works closely with industry, states, interest groups, national laboratories, utilities, universities, and others to set research and development priorities, identify program opportunities, deploy technologies, and disseminate information more effectively. EERE involves its customers and partners in all stages of research and development, including concept development, market and technical feasibility studies, system and component design, research plans, prototype construction and testing, demonstrations, and deployment. In many cases, EERE activities are jointly funded with private sector or other public sector players.

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
ENERGY EFFICIENCY AND RENEWABLE ENERGY
ENERGY SUPPLY

(Tabular dollars in thousands, Narrative in whole dollars)

SOLAR AND RENEWABLE ENERGY

PROGRAM MISSION

The vision for the Solar and Renewable Energy programs over the next decade reflects the movement of the U.S. as we and the other nations of the world move toward an environmentally sound, sustainable, and secure energy future. By 2010, we anticipate that a robust U.S. renewable and enabling energy technologies industry will capture a significant share of world markets. To help achieve this goal, the Office of Energy Efficiency and Renewable Energy (EERE), through its many partnerships, will carry out its leadership mission by encouraging the development and use of renewable and enabling technologies. The family of renewable energy systems discussed in this budget request—winnowed during the 1980's from examination of over three times the number of technologies presented herein—offer the most attractive and complete set of energy options to meet anticipated energy and environmental requirements. The activities and programs described will establish and ensure that clean choices are available for our future when they are most needed.

The Solar and Renewable Resource Technologies Program funds research and development in two related areas: (1) R&D of new, efficient, reliable and environmentally sound renewable energy technologies for the utility, transportation, industrial, and buildings sectors; and (2) R&D of power sector technologies necessary for integration of renewable energy systems into the electricity grid and that improve the efficiency of the electric sector. In addition, the Program provides support for pre-commercial deployment of solar and renewable energy technologies into domestic and international markets.

Past funding of these R&D activities has yielded remarkable results in renewable energy technology efficiency and economics, bringing the concept of a renewable-based electric power system closer to reality. Royal/Dutch Shell Company's planning group, an internationally recognized leader in energy forecasting and planning, projects significant market share for renewable energy technologies in the first decades of the 21st century, largely based on the technology cost reductions spurred by DOE's R&D investments.

SOLAR AND RENEWABLE ENERGY - PROGRAM MISSION (Cont'd)

The Program's funding request for Fiscal Year 1999 is driven by three objectives central to achieving long-term success:

1. Maintain U.S. technological superiority in renewable energy and advanced utility system technologies by funding a balanced portfolio of R&D in renewable systems and supporting electric technologies.
2. Improve environmental quality through increased use of non-polluting renewable energy technologies, and advanced electric power systems.
3. Expedite the transfer of technology and manufacturing process improvements to the U.S. renewable energy industry which will enable them to increase the deployment of their renewable energy systems in the U.S. and to better compete for rapidly expanding global markets for renewable energy systems.

Office of Utility Technologies (OUT) Benefits:

Analysis of OUT program benefits indicates that by 2010, more than one quad of primary energy will be displaced by clean renewable energy. This is equivalent to not building one hundred coal power plants of 250 MW each. This displacement will result in multiple benefits for the country. Diversity of the U.S. energy systems will be increased, thus enhancing U.S. energy security. Up to 32 million metric tons of carbon emissions will be eliminated, helping the country meet its energy needs without harming the global environment. Emissions of other environmental pollutants will also be proportionately reduced. There are also huge potential economic benefits from the sale of OUT-related technologies in international electricity markets. The International Energy Agency forecasts that by the year 2010, the world will add 1,400,000 MW of electricity capacity to today's level of 2,921,000 MW, 50% of which will be in developing countries. Over this period, the export market potential for renewable energy technologies will exceed \$100 billion, with important job creation benefits for the U.S. Further, the World Bank has estimated that, over the next decades, developing country demand for new generating capacity will be appropriately 5,000,000 MW, with a market value in the trillions of dollars.

PERFORMANCE MEASURES:

1. Market penetration: The ultimate success of an R&D program is in the commercial application of the technology in the marketplace. The commercial applications we see today are the results of R&D conducted several years earlier.

SOLAR AND RENEWABLE ENERGY - PROGRAM MISSION (Cont'd)

Market penetration is a good measure of the commercial application of a technology that has active R&D programs. Two key ways of measuring market penetration for solar and renewable technologies are total installed capacity and cost of production, both for domestic as well as international export applications. The performance objectives of the Solar and Renewable Resource Technologies Program for U.S.-produced systems installed domestically as well as overseas in the year 2000 are:

Technologies	Total Installed Capacity by 2000 ¹		Cost of Production		Other Measures
	Domestic	Overseas	Current	2000	
Photovoltaics	300 MWe	200 MWe	>20 ¢ per kWh	10 to 15 ¢ per kWh	
Solar Thermal	365 MWe	30 MWe	17 ³ per kWh	10 to 12 ¢ per kWh	
Biopower	8,000 MWe	8,000 MWe	7 to 9 ¢ per kWh	6 to 7 ¢ per kWh	
Wind	2,200 MWe	9,300 MWe	4 to 5 ¢ per kWh	2.5 to 3.5 ¢ per kWh	
Geothermal	2,500 MWe	5,500 MWe	5 to 8 ¢ per kWh	3.5 ¢ per kWh	reduce electric peak loads by 2,000 MW from Geothermal Heat Pumps
Hydrogen	10 ² MWe	N/A	N/A	4.5 ¢ per kWh ²	
Solar Hot Water	Goal: 40-60% increase in market from current annual sales of 12,000 equivalent KWe/yr to 27,500 KWe/yr in 2000		8 ¢ per kWh	6 ¢ per kWh	
	Production of Transportation Fuels		Cost of Fuels Production (dollars per gallon)		
	Current	2000	Current	2000	
Biofuels	0	400	1.22	0.90	

1. Capacity resulting from U.S. production and sales.

2. Based upon Plug Power and International Fuel Cells' management plan to produce fuel cell units for stand-alone power production.

3. Dispatchable, using solar thermal trough technology.

SOLAR AND RENEWABLE ENERGY - PROGRAM MISSION (Cont'd)

2. Improvement of technical indices of system performance: These include photovoltaic conversion efficiencies, wind turbine efficiencies, geothermal power plant conversion efficiencies, and improving the hot-gas cleanup performance of biomass-powered thermal systems.
3. Initiate and complete proof-of-concept and field validation projects. All renewable energy technology programs incorporate pilot-scale projects as key elements in the demonstration of the capability and economics of renewable technologies. The ability to successfully complete such projects with industry partners as part of an integrated R&D program focused on expedited technology transfer is key.

The fiscal year 1999 Solar and Renewable Technology Program is designed to build upon these accomplishments through a focused and intensive R&D effort. This effort will be guided by a strong analytical capability and close consultation and collaboration with the companies and customers that will carry successful technologies into the market.

Key milestones for the renewable energy technology are summarized in the following chart:

**SOLAR AND RENEWABLE ENERGY
PROGRAM FUNDING PROFILE**
(Dollars in thousands)

Sub-Program	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Budget Request
Solar Building Technology Research	\$ 2,277	\$ 2,720	\$(62)	\$ 2,658	\$ 5,000
Photovoltaic Energy Systems	59,210	66,511	(1,013)	65,498	78,800
Solar Thermal Energy Systems	21,924	16,775	(256)	16,519	22,500
Biopower/Biofuels Energy Systems	54,327	59,750	(910)	58,840	89,791
Wind Energy Systems	28,646	33,030	(503)	32,527	43,500
Renewable Energy Production Incentive Program	2,000	3,000	(46)	2,954	4,000
Solar Program Support	0	0	0	0	14,000
International Solar Energy Program	661	1,375	0	1,375	8,800
Solar Technology Transfer	0	0	0	0	1,360
National Renewable Energy Laboratory	500	1,000	0	1,000	5,000
Geothermal	29,630	29,500	(449)	29,051	33,000
Hydrogen Research	14,809	16,250	(247)	16,003	24,000
Hydropower Development	973	750	(11)	739	4,000
Renewable Indian Energy Resources	4,000	4,000	(61)	3,939	0
Electric Energy Systems and Storage	31,378	43,450	(662)	42,788	38,500
Program Direction	13,052	15,651	0	15,651	17,000
Federal Building/Remote Power Initiative	0	5,000	(76)	4,924	0
Subtotal, Research	\$ 263,387	\$ 298,762	(4,296)	\$ 294,466	\$ 389,251
 National Renewable Energy Laboratory Construction	 2,800	 2,200	 0	 2,200	 0
Subtotal, Solar and Renewable Energy	\$ 266,187	\$ 300,962	(4,296)	\$ 296,666	\$ 389,251
 Adjustments	 (22,367)a/	 (24,447)a/	 0	 (24,447)a/	 (17,000)a/
Total Solar and Renewable Energy	\$ 243,820	\$ 276,515	(4,296)	\$ 272,219	\$ 372,251

a/ Use of prior year balances

**SOLAR AND RENEWABLE ENERGY
PROGRAM FUNDING PROFILE (Cont'd)**
(Dollars in thousands)

Public Law Authorizations:

- P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
- P.L. 94-385, "Energy Conservation and Production Act" (ECPA) (1976)
- P.L. 95-91, "Department of Energy Organization Act" (1977)
- P.L. 94-618, "Energy Tax Act of 1978"
- P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
- P.L. 95-620, "Powerplant and Industrial Fuel Use Act of 1978"
- P.L. 96-294, "Energy Security Act" (1980)
- P.L. 100-12, "National Appliance Energy Conservation Act of 1987"
- P.L. 100-615, "Federal Energy Management Improvement Act of 1988"
- P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989"
- P.L. 101-549, "Clean Air Act Amendments of 1990"
- P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentive Act of 1990"
- P.L. 102-486, "Energy Policy Act of 1992"

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY
(Dollars in thousands)

**SOLAR AND RENEWABLE ENERGY
PROGRAM FUNDING DETAIL**

<u>Program/Subprogram/Activity</u>	<u>FY 1997 Current Appropriation</u>	<u>FY 1998 Current Appropriation</u>	<u>FY 1999 Request</u>
I. Solar and Renewable Energy	<u>\$266,187</u>	<u>\$296,666</u>	<u>\$389,251</u>
A. Solar Building Technology Research	<u>2,277</u>	<u>2,658</u>	<u>5,000</u>
1. Space Conditioning and Water Heating	2,277	2,658	5,000
B. Photovoltaic Energy Systems	<u>59,210</u>	<u>65,498</u>	<u>78,800</u>
1. Fundamental Research	9,921	11,000	11,000
2. Advanced Materials and Devices	23,289	24,000	27,000
3. Collector Research and Systems Development	26,000	30,498	40,800
C. Solar Thermal Energy Systems	<u>21,924</u>	<u>16,519</u>	<u>22,500</u>
1. Solar Thermal Electric R&D	<u>21,924</u>	<u>16,519</u>	<u>22,500</u>
a. Thermal Systems Research	8,387	6,150	5,500
b. Power Applications Research	13,537	10,369	17,000
D. Biopower/Biofuels Energy Systems	<u>54,327</u>	<u>58,840</u>	<u>89,791</u>
1. Biopower Energy Systems- Utilities	<u>27,162</u>	<u>28,164</u>	<u>42,900</u>
a. Thermochemical Conversion	1,272	1,500	2,700
b. System Development	18,262	21,392	37,300
c. Biomass for Cogeneration	3,953	2,564	2,900
d. Feedstock Production	2,100	1,723	0
e. Regional Biomass Energy Program	1,575	985	0

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**SOLAR AND RENEWABLE ENERGY
PROGRAM FUNDING DETAIL**

<u>Program/Subprogram/Activity</u>	<u>FY 1997 Current Appropriation</u>	<u>FY 1998 Current Appropriation</u>	<u>FY 1999 Request</u>
2. Biofuels Energy Systems - Transportation	<u>\$27,165</u>	<u>\$30,676</u>	<u>\$46,891</u>
a. Ethanol Production	22,165	25,426	36,391
b. Biodiesel Production	750	750	1,000
c. Feedstock Development	2,500	2,500	6,000
d. Regional Biomass Energy Program	1,750	2,000	3,500
E. Wind Energy Systems	<u>28,646</u>	<u>32,527</u>	<u>43,500</u>
1. Applied Research	12,200	11,500	10,700
2. Turbine Research	8,500	13,000	24,800
3. Cooperative Research & Testing	7,946	8,027	8,000
F. Renewable Energy Production Incentive Program	2,000	2,954	4,000
G. Solar Program Support	<u>0</u>	<u>0</u>	<u>14,000</u>
1. Electric Restructuring	0	0	4,000
2. 5-Year Open Competitive Solicitation	0	0	10,000
H. International Solar Energy Program	661	1,375	8,800

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SOLAR AND RENEWABLE ENERGY
PROGRAM FUNDING DETAIL

<u>Program/Subprogram/Activity</u>	<u>FY 1997 Current Appropriation</u>	<u>FY 1998 Current Appropriation</u>	<u>FY 1999 Request</u>
I. Solar Technology Transfer	<u>\$0</u>	<u>\$0</u>	<u>\$1,360</u>
1. Information & Communications	0	0	1,360
J. National Renewable Energy Laboratory	<u>3,300</u>	<u>3,200</u>	<u>5,000</u>
1. Facility Maintenance	500	1,000	5,000
2. Construction	2,800	2,200	0
K. Geothermal	<u>29,630</u>	<u>29,051</u>	<u>33,000</u>
1. Geothermal Electric R&D and Deployment	23,148	22,651	29,500
2. Geothermal Heat Pump Deployment	6,482	6,400	3,500
L. Hydrogen Research and Development	14,809	16,003	24,000
M. Hydropower Development	973	739	4,000
N. Renewable Indian Energy Resources Program	4,000	3,939	0
O. Electric Energy Systems and Storage	<u>31,378</u>	<u>42,788</u>	<u>38,500</u>
1. High Temperature Superconductivity R&D	19,518	32,005	32,000
2. Energy Storage R&D	3,954	3,890	6,000
3. Electric & Magnetic Fields R&D	7,906	6,893	0
4. Climate Challenge	0	0	500

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SOLAR AND RENEWABLE ENERGY
PROGRAM FUNDING DETAIL

<u>Program/Subprogram/Activity</u>	<u>FY 1997 Current Appropriation</u>	<u>FY 1998 Current Appropriation</u>	<u>FY 1999 Request</u>
P. Program Direction	<u>\$13.052</u>	<u>\$15.651</u>	<u>\$17.000</u>
1. Golden Field Office	<u>2,230</u>	<u>1,890</u>	<u>2,526</u>
a. Salary and Benefits	1,326	980	915
b. Travel	72	75	80
c. Support Services	447	464	852
d. Other Related Expenses	385	371	679
2. Idaho Operations Office	<u>99</u>	<u>179</u>	<u>186</u>
a. Salary and Benefits	85	176	181
b. Travel	14	3	5
c. Support Services	0	0	0
d. Other Related Expenses	0	0	0
3. Headquarters.	<u>10,723</u>	<u>13,582</u>	<u>14,288</u>
a. Salary and Benefits	8,864	8,750	8,320
b. Travel	267	320	335
c. Support Services	0	2,862	3,943
d. Other Related Expenses	1,592	1,650	1,690
<u>Total Program Direction Summary</u>	<u>13.052</u>	<u>15.651</u>	<u>17.000</u>
a. Salary and Benefits	10,275	9,906	9,416
b. Travel	353	398	420
c. Support Services	447	3,326	4,795
d. Other Related Expenses	1,977	2,021	2,369

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SOLAR AND RENEWABLE ENERGY
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<u>Program/Subprogram/Activity</u>	<u>FY 1997 Current Appropriation</u>	<u>FY 1998 Current Appropriation</u>	<u>FY 1999 Request</u>
Q. Federal Building/Remote Power Initiative	\$0	\$4,924	\$0
SUBTOTAL Energy Supply	266,187	296,666	389,251
Use of Prior Year Balances Solar & Renewable			
TOTAL Energy Supply	\$243,820	\$272,219	\$372,251
Staffing (FTEs):			
Golden Field Office	24	17	15
Idaho Operations Office	1	2	2
Headquarters	<u>98</u>	<u>92</u>	<u>85</u>
Total FTEs	123	111	102

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**SOLAR AND RENEWABLE ENERGY
PROGRAM FUNDING BY SITE**

<u>Field Offices/Sites</u>	<u>FY 1997 Current Appropriation</u>	<u>FY 1998 Original Appropriation</u>	<u>FY 1998 Adjustment</u>	<u>FY 1998 Current Appropriation</u>	<u>FY 1999 Budget Request</u>
ALBUQUERQUE OPERATIONS OFFICE					
Albuquerque Operations Office	\$13			\$1,100	\$900
Atlanta Regional Support Office	305			2	205
Boston Regional Support Office	1,990			840	900
Chicago Regional Support Office	884			220	420
Denver Regional Support Office	1,573			413	700
Philadelphia Support Office	210			2	203
Seattle Regional Support Office	495			0	200
Los Alamos National Laboratory	4,211			5,300	5,700
Sandia National Laboratory	31,937			30,512	36,553
National Renewable Energy Laboratory	77,382			77,543	95,015
Golden Field Office	<u>37,988</u>			<u>42,106</u>	<u>64,186</u>
Subtotal, Albuquerque Operations Office	156,988	160,294		158,038	204,982
CHICAGO OPERATIONS OFFICE					
Chicago Operations Office	4,110			2,924	4,400
Argonne National Laboratory	2,920			4,000	4,000
Brookhaven National Laboratory	<u>1,865</u>			<u>5,190</u>	<u>850</u>
Subtotal, Chicago Operations Office	8,895	12,287		12,114	9,250

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<u>Field Offices/Sites</u>	<u>FY 1997 Current Appropriation</u>	<u>FY 1998 Original Appropriation</u>	<u>FY 1998 Adjustment</u>	<u>FY 1998 Current Appropriation</u>	<u>FY 1999 Budget Request</u>
IDAHO OPERATIONS OFFICE					
Idaho Operations Office	18,639			18,614	20,790
Idaho National Engineering Laboratory	<u>1,053</u>	<u> </u>	<u> </u>	<u>200</u>	<u>500</u>
Subtotal, Idaho Operations Office	19,692	19,083		18,814	21,290
OAK RIDGE OPERATIONS OFFICE					
Oak Ridge Operations Office	1,300			2,600	1,000
Office of Scientific and Technology Information	16,066			20,904	23,008
Oak Ridge National Laboratory	<u>14,799</u>	<u> </u>	<u> </u>	<u>15,723</u>	<u>17,800</u>
Subtotal, Oak Ridge Operations Office	32,165	39,787		39,227	41,808
RICHLAND OPERATIONS OFFICE					
Pacific Northwest Laboratory	6,008	2,333		2,300	1,850
OAKLAND OPERATIONS OFFICE					
Lawrence Berkeley National Laboratory	610			1,800	1,800
Lawrence Livermore National Laboratory	<u>1,109</u>	<u> </u>	<u> </u>	<u>800</u>	<u>1,000</u>
Subtotal, Oakland Operations Office	1,719	2,637		2,600	2,800
NEVADA OPERATIONS OFFICE					
Nevada Operations Office	0	0	0	0	200

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY
(Dollars in thousands)

SOLAR AND RENEWABLE ENERGY
PROGRAM FUNDING BY SITE

<u>Field Offices/Sites</u>	<u>FY 1997 Current Appropriation</u>	<u>FY 1998 Original Appropriation</u>	<u>FY 1998 Adjustment</u>	<u>FY 1998 Current Appropriation</u>	<u>FY 1999 Budget Request</u>
MORGANTOWN ENERGY TECHNOLOGY CENTER	200	0	0	0	1,500
PITTSBURGH ENERGY TECHNOLOGY CENTER	2,161	5,882		5,799	5,937
HEADQUARTERS	<u>38,359</u>	<u>58,659</u>	—	<u>57,774</u>	<u>99,634</u>
SUBTOTAL	266,187	300,962		296,666	389,251
Adjustment	a	a	0	a	
TOTAL	<u>\$243,820</u>	<u>\$276,515</u>	—	<u>\$272,219</u>	<u>\$372,251</u>

a. Use of prior year balances

SOLAR AND RENEWABLE ENERGY

SOLAR BUILDING TECHNOLOGY RESEARCH

(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives: The mission of the Solar Buildings Technology Research Program is to conduct research and development (R&D) that will provide economically competitive sources of solar energy in residential, commercial, and industrial buildings. The buildings sector consumes over a third of the energy used in the United States. The industrial sector consumes another third. Most of this is thermal energy used for hot water, space heating and cooling, and industrial processes. The Solar Buildings program addresses a market that consists of 95 million households, 4.5 million commercial buildings, 9 million pools and spas, and 750,000 industrial processes that use steam at temperatures less than 400°F. By the year 2020, solar energy could displace 0.4 quad of the thermal energy needed by that market. Reducing the use of fossil fuels by that amount would improve the quality of our air and reduce the emission of greenhouse gases (carbon equivalent) by more than 9 MMTons. On June 26, 1997, President Clinton announced The Million Solar Roofs initiative to place solar energy systems on one million U.S. buildings by the end of 2010. Half of these million solar (solar hot water and/or photovoltaics) systems may be solar water heating systems. This program will work with customers to ensure that technologies are developed that will meet the needs of the public and the marketplace, improve the environment, and guarantee continued global competitiveness of U.S. industry. R&D goals are to develop solar building technologies which are competitive with electricity in the near term and gas/oil in the long term.

Utilities, builders, and other customers are helping guide the Solar Buildings program by identifying barriers to their use of the technology. These barriers include cost, reliability, and integration of the technology with the building. The program is addressing these barriers. The resulting R&D activities form the base upon which the cost of solar water heating will be reduced to 4 cents per kWh (equivalent electricity costs) and solar process heat to \$4/MMBtu. These cost reductions follow previous improvements in the technology. Since 1980, for example, the cost of solar water heating has dropped from about 20 cents per kWh to about 8 cents per kWh today. The cost of solar process heat has been reduced from \$45/MMBtu to \$9/MMBtu. Research supported by DOE also led to a technical breakthrough (the transpired solar collector) which reduced the cost of solar air heating from about 20 cents per kWh to about 2 cents per kWh. Achieving the above goals will make solar water heating cost-competitive with electricity, and solar cooling/process heat competitive with natural gas. Achieving the above goals is critical if the President's Million Solar Roofs Initiative is to be a success.

SOLAR AND RENEWABLE ENERGY

SOLAR BUILDING TECHNOLOGY RESEARCH (Cont'd)

Mission Supporting Goals and Objectives (Cont'd):

To achieve the goals, the program has efforts in **technology R&D, precompetitive field validation, and quality assurance and customer information** activities.

Technology R&D.

Objective: reduce cost of solar energy used for building applications through improved technology.

The major thrust for the program will be on technology R&D that reduces the cost and increases the service life of the technology. Competitive solicitations initiated in FY 1997 resulted in contracts with universities and industry that are providing the framework for improvements that will reduce costs through better manufacturing processes, the use of new materials, and innovative design.

Precompetitive Field Validation.

Objective: understand the needs of builders, utilities, homebuyers, and other customers; use that information to guide R&D; and validate improvements through field tests.

The program will work with interested electric utilities in the Utility Solar Water initiative (USH2O) to develop the energy service company approach for delivering solar water heating to end-use customers in new utility programs across the country. The utilities have found that, under certain conditions, they can make a profit by retaining ownership of the solar technology and selling hot water to their customers. The program is also working with other customers (e.g. builders, air conditioning manufacturers) to identify the improvements necessary to make solar technology fully acceptable for the residential construction and commercial markets. The program will coordinate with utilities, builders, and other potential end users to keep them abreast of changes in the technology. It will use their input to guide the Program's R&D activities and validate those improvements through cost-shared field tests. System performance and reliability data from these systems will benefit both the utilities/builders and the solar industry. This activity brings together the solar industry and their customers in a forum that focuses R&D and will hasten the deployment of solar technology.

Quality Assurance and Customer Information:

Objective: improve customer confidence in solar thermal systems.

SOLAR AND RENEWABLE ENERGY

SOLAR BUILDING TECHNOLOGY RESEARCH (Cont'd)

Mission Supporting Goals and Objectives (Cont'd):

The program will support the Solar Rating and Certification Corp, an industry driven organization which develops standards for solar water heating systems, in improving its computer models for estimating system reliability. It will also develop educational information describing the costs and benefits of the solar systems.

A. Estimates of Benefits:

At the proposed funding levels, the Solar Buildings Appliances R&D Program is expected to yield the following quantifiable benefits:

	2000	2010	2020

Total Primary Energy Displaced (Quads)	0.03	0.09	0.43
Total Cost Savings (Millions \$ 1995)	259	705	3,300
Carbon Equivalent Emissions (MM Tons)	0.64	1.79	9.36

B. Performance Measures (highlights):

Goals for 2000

The following performance measures will allow the Solar Buildings Technology Research Program to determine progress toward the program goal for 2000 of reducing the cost of solar water heating from 8 cents per kWh today to 6 cents per kWh, and solar cooling and process heating from \$9/MMBtu to \$7/MMBtu. Additionally, system life expectancies will increase from a range of 15 years to 20 years.

SOLAR AND RENEWABLE ENERGY

SOLAR BUILDING TECHNOLOGY RESEARCH (Cont'd)

Mission Supporting Goals and Objectives (Cont'd):

FY 1997 Performance Measures

- Worked with builders, utilities, the solar industry, and other potential customers to develop a new strategic plan for the program and identify technology improvements required for solar hot water to become an integral part of the residential construction market:
 - 9 workshops held around the country with home builders, architects, roofers, and plumbers.
 - research task initiated to understand the perceptions of home buyers concerning solar water heating systems
 - utility Business Prospectus report completed and sent to over 100 utilities
- Two additional utility cost-shared solar building initiatives were established for promoting solar water heating markets.
- Initiated prototype development of next generation of solar domestic hot water equipment with potential for a 20-40% increased cost effectiveness.
 - four contracts were initiated to assist industry in reducing costs by improving their manufacturing processes
 - three university and five industry contracts were initiated to identify new components that could reduce solar water heating system costs
- Five contracts were initiated to develop prototype solar powered absorption air conditioning systems.
- National sales of 6,000 solar water heating systems were achieved.

FY 1998 Performance Measures

- Implement the new strategic plan which focuses on understanding the needs of the customer (homebuilders, homebuyers, utility, and Energy Service Companies) and adapting solar technology to these needs. The strategy addresses the barriers to solar energy by emphasizing roof integration, lower cost, and increased reliability.

SOLAR AND RENEWABLE ENERGY

SOLAR BUILDING TECHNOLOGY RESEARCH (Cont'd)

Mission Supporting Goals and Objectives (Cont'd):

- Complete the first phase of the manufacturing contracts, which identify and quantify manufacturing improvements, and select contracts for phase 2, which would assist the manufacturers in implementing the improvements.
- Complete first phase of the industry and university contracts (concept development) selected to significantly reduce solar water heating costs. Concepts include freeze and overheating protection, polymer based systems, and use of heat pipes that could eliminate the need for pumps and controllers.
- Complete evaluation of solar absorption air conditioning concepts.
- Initiate electric utility solar building initiatives resulting from the Business Prospectus distributed in FY 1997.
- National sales of 7,000 solar water heating systems.

FY 1999 Performance Measures

- Universities and industry complete design and analysis of their low-cost solar water heater concepts.
- Implementation of manufacturing improvements leading to solar technologies capable of producing water heating at 6 cents per kWh, down from a baseline of 8 cents per kWh in 1997.
- Support the Presidents's Million Solar Roofs Initiative through partnerships and technical assistance so that at least 15,000 solar roofs (solar thermal and/or PV) will be installed in 1999. Twenty-five major partnerships will be established under this initiative.
- Initiate field validation of "next generation" solar water systems in cost-shared programs with builders and electric utilities.

SOLAR AND RENEWABLE ENERGY

SOLAR BUILDING TECHNOLOGY RESEARCH (Cont'd)

Mission Supporting Goals and Objectives (Cont'd):

- Conduct experiments that prove the potential of low temperature solar energy to economically dry crops such as coffee, cocoa, and tea while reducing the CO₂ emissions.

FY 2000-2005 Performance Measures

- Field validate solar thermal technologies capable of producing solar water heating and solar process heating at costs of 5 cents per kWh and \$6 per MMBtu, respectively.
- National sales annually of 45,000 solar water heating systems by 2005
- Install a total of 300,000-500,000 solar thermal heating and/or photovoltaic roof systems under the Million Solar Roofs Initiative (2005-2007).

SOLAR AND RENEWABLE ENERGY

SOLAR BUILDING TECHNOLOGY RESEARCH (Cont'd)

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
Space Conditioning and Water Heating	<u>\$ 2,277</u>	<u>\$ 2,658</u>	<u>\$ 5,000</u>	<u>\$ 2,342</u>	<u>88%</u>
Total, Solar Building Technology Research	<u>\$ 2,277</u>	<u>\$ 2,658</u>	<u>\$ 5,000</u>	<u>\$ 2,342</u>	<u>88%</u>

III. Performance Summary - Accomplishments:

Space Conditioning and Water Heating	FY 1997	FY 1998	FY 1999
Quality Assurance and Customer Information: 1997 - Completed technical support on remaining solar system reliability issues for a voluntary, industry-driven National Rating and Certification Procedure for all solar domestic hot water system types; completed transfer of implementation process for certifying solar systems to industry. 1998 - Provide technical support to expand rating and certification procedures for new system designs being developed by industry. 1999 - Provide support to the Solar Rating and Certification Corp, an industry driven organization that evaluates the efficiency and reliability of solar water heaters, to improve computer models that predict the reliability of solar systems made of new materials. Educational materials will be developed that describe the costs and benefits of solar water heating systems. Work with partners of the Million Solar Roofs Initiative to remove restrictions to the use of solar energy in communities.	\$250	\$140	\$500

SOLAR AND RENEWABLE ENERGY

SOLAR BUILDING TECHNOLOGY RESEARCH (Cont'd)

Space Conditioning and Water Heating (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Precompetitive Field Validation:</p> <p>1997 - Completed Business Prospectus report which provided a model of how electric utilities could satisfy the needs of their customers and produce a profit by selling solar hot water (but maintaining ownership of the solar systems). This was sent to more than 100 utilities and thus far has led to the establishment of 2 utility-energy service company initiatives. The program hosted 9 workshops with home builders throughout the country and conducted research to identify the perceptions of home buyers toward solar energy systems.</p> <p>1998 - In support of the Million Solar Roofs Initiative, establish 2 utility-energy service company solar projects in which the program provides technical assistance on system performance and cost-sharing of field validation of the system; provide similar assistance to builder consortia resulting in 1-2 community scale solar field validations addressing the residential construction market. Provide educational material and technical data to the consortia and others in the Building Sector.</p> <p>1999 - Increase efforts with builders and utilities to achieve the following goals of : (1) identify the barriers keeping them from using solar technology, and (2) evaluate the potential of new solar water systems to meet their needs. This includes sponsoring workshops, providing data from at least two cost-shared field projects, and making available technical support. It also includes exploring the potential for utilities to use solar water heating as a profitable business opportunity in the context of restructuring.</p>	\$927	\$1,100	\$1,000

SOLAR AND RENEWABLE ENERGY

SOLAR BUILDING TECHNOLOGY RESEARCH (Cont'd)

Space Conditioning and Water Heating (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Technology Development</p> <p>1997 - Initiated contracts with universities and industry to develop low-cost solar water heating systems that could potentially reduce system costs by 50%; initiated contracts with industry to identify advanced manufacturing processes for solar building equipment offering 20% increased cost effectiveness and 20 year service lives; initiated contracts with industry and universities to adapt solar technology to power absorption air conditioners.</p> <p>1998 - Complete analysis of low-cost solar water heating systems concepts identified in FY 1997; complete identification of advanced manufacturing processes and evaluation of their potential to reduce system costs; complete solar absorption air conditioning design and analyses.</p> <p>1999 - Initiate second phase of 2-3 cost-shared contracts with solar industry assisting them in improving their manufacturing processes. Manufacturing experts will be made available to the solar manufacturers to analyze their processes and recommend improvements. Conduct research exploring new concepts and the use of new materials for significantly reducing the cost of solar water heating, solar cooling, and process heat systems. Approximately 3-6 university or industry contracts would result from this activity. Each would design, build, and test prototype systems. For the most promising concepts, facilitate the process of technology transfer to the solar industry.</p>			
	\$1,100	\$1,418	\$3,500
TOTAL Solar Buildings Technology Research	\$2,277	\$2,658	\$5,000

SOLAR AND RENEWABLE ENERGY

SOLAR BUILDING TECHNOLOGY RESEARCH (Cont'd)

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

<u>Space Conditioning and Water Heating:</u> The primary change is an expanded technology development program that is focused on reducing the cost of solar water heating technology to 4 cents per kWh or less, which would make it competitive in wide areas of the U.S. with other advanced technologies presently under development. It would also explore concepts for reducing the cost of solar cooling and process heat to \$4/MMBtu. The funding increase supports university research as well as contracts with the solar industry that are expected to reduce manufacturing costs of solar water heating systems. There would also be increased efforts with builders and utilities to identify and overcome barriers to the increased use of solar water heating. These tasks support the Million Solar Roofs Initiative by lowering the cost of solar energy and increasing customer confidence in the technology.	\$2,342,000
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Total Funding Change, Solar Building Technology Research	
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\$2,342,000

SOLAR AND RENEWABLE ENERGY

PHOTOVOLTAIC ENERGY SYSTEMS

(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives: The mission of the Photovoltaic Technology Program is to conduct the research and development (R&D) necessary to develop an economically competitive renewable source of electricity for our nation, thereby ensuring a more secure energy future. R&D goals are to increase the conversion efficiency and performance of photovoltaic devices, reduce manufacturing costs of components and systems, and increase the reliability and lifetime expectancy of modules and installed systems.

Photovoltaic R&D activities are integral to advancing the science and technology base that will maintain steady progress toward long-term goals of improved performance and lower costs. The U.S. photovoltaic industry has experienced average growth rates of 23% in international and domestic sales over the past seven years. This is the direct result of a strong and vigorous National R&D Program that has established the U.S. photovoltaic industry as a world leader in science and engineering excellence. A strong R&D program is essential to maintain our nation's world leadership in this strategic energy industry, which produces high-technology jobs, product exports, and economic growth. Advanced photovoltaic R&D is still considered by industry to be too high-risk and long-term to support on its own. Therefore, a key element of the PV program is to cost-share advanced R&D and technology improvement in cooperation with industry for its continued development of globally-competitive products.

The FY 1999 budget presents a balanced effort in fundamental and applied research, materials and device development, manufacturing process R&D, module reliability, and system testing and evaluation. A major portion of the budget will be used in competitive procurements to fund highly leveraged cost-shared projects with U.S. utilities and the emergent PV industry.

A key thrust in FY 1999 is the President's Million Solar Roofs Initiative. Outreach activities for the Initiative will establish at least 25 partnerships to install PV and/or solar thermal energy systems across the nation. Development of the technology to ensure that the PV systems meet the requirements of builders and codes and standards will also be conducted.

Fundamental research activities will continue on several photovoltaic semiconductor materials to resolve issues that limit current technology, and to develop new ideas for next generation (post-2000) technologies. Advanced materials and devices work will continue cost-shared research with industry to improve device efficiency and stability, particularly for large-area thin-film deposition systems. Manufacturing process R&D will continue cost-shared industry research to reduce module manufacturing costs, improve module performance, and stimulate investment in new manufacturing production lines. These research activities are core program

SOLAR AND RENEWABLE ENERGY

PHOTOVOLTAIC ENERGY SYSTEMS (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

efforts to develop the advanced technologies that are essential to maintaining U.S. competitiveness in the next 5 to 10 years. Module reliability research will continue to support reliability testing of modules to improve operational lifetime in the field. System component reliability efforts will be increased to help increase the lifetime of fielded systems. In cooperation with the Utility Photovoltaic Group (UPVG), efforts will be continued to complete high leverage cost-shared utility projects designed to establish technical and economic validation in specific high-value applications. In addition, research and analysis relating to restructuring in the electric utility industry will be conducted on issues associated with integration of photovoltaic systems into an increasingly competitive industry framework.

A. Estimates of Benefits

At the proposed funding levels, the Photovoltaic Technology R&D Program is expected to yield the following quantifiable benefits in the U.S.; these are cumulative benefits assuming a baseline of zero in 1998 for grid connected power modules:

	2000	2010	2020

Annual Primary Energy Displaced (Quads)	0	0.02	0.10
Carbon Equivalent Emissions Reductions (MMT)	0	0.33	1.4

The U.S. photovoltaic industry has been growing at an average annual rate of 23% over the past seven years and is now the leader in sales throughout the world. In 1996, 73% of sales were exported to foreign markets. The strong and aggressive DOE R&D program has been the key to enabling the U.S. PV industry to be the technology and product leader in a very competitive and rapidly growing global marketplace.

B. Performance Measures

Goals for 2000

SOLAR AND RENEWABLE ENERGY

PHOTOVOLTAIC ENERGY SYSTEMS (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

- Increase the conversion efficiency of commercial thin film modules from the current 7% to 10% and from the current 14% to 15% for crystalline silicon.
- Reduce the retail sales price of commercial modules by 15% from current average costs of about \$4.25/watt.
- More than double U.S. PV industry cumulative sales of power modules from 215 megawatts in 1996 to 500 megawatts (U.S. and export sales).

FY 1997 Performance Measures

- Completed construction and begin testing and evaluating the 11 UPVG Round 1 utility PV systems totaling 5.6 megawatts of installed capacity.
- Tested a low-cost, improved module encapsulant with 25 or more-year lifetime.
- Achieved greater than 7% efficient thin-film large-area commercial modules.
- Evaluated performance of a thin-film PV roofing shingle on several buildings.

SOLAR AND RENEWABLE ENERGY

PHOTOVOLTAIC ENERGY SYSTEMS (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

FY 1998 Performance Measures

- Develop an 18% efficient prototype thin-film solar cell.
- Reduce retail sales price of modules by 5% from present baseline of about \$4.25 per peak watt.
- Achieve retail sales of 8% efficient cadmium telluride (CdTe) large area modules by industry.
- Establish at least 10 partnerships for the Million Solar Roofs Initiative through the Utility Photovoltaics Group by the end of 1998.

FY 1999 Performance Measures

- Complete Phase 2 Preliminary Engineering Development and initiate Phase 3 Prototype Development/Field Verification for PV:BONUS project.
- Develop 13% efficient stable prototype amorphous silicon solar cells.
- Develop codes, standards and safety specifications for residential PV roof systems.
- Support of the President's Million Solar Roofs Initiative through partnerships and technical assistance so that at least 15,000 solar (PV and/or solar thermal energy systems) roofs will be installed in 1999. Twenty-five major partnerships will be established under this Initiative.

SOLAR AND RENEWABLE ENERGY

PHOTOVOLTAIC ENERGY SYSTEMS (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

FY 2000 - 2005 Performance Measures

- Develop 13% efficient stable prototype thin-film module. (2000)
- Test a low-cost, stable module encapsulant compatible with 30-year module life. (2001)
- Achieve greater than 300 megawatts of cumulative installed PV systems in the U.S. (2002)
- Install a total of 300,000-500,000 solar (PV and/or solar thermal energy) roof systems under Million Solar Roofs Initiative (2005-2007)

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
Fundamental Research	\$ 9,921	\$ 11,000	\$ 11,000	\$ 0	0%
Advanced Materials and Devices	23,289	24,000	27,000	3,000	13%
Collector Research and Systems Development	<u>26,000</u>	<u>30,498</u>	<u>40,800</u>	<u>10,302</u>	<u>34%</u>
Total, Photovoltaic Energy Systems	<u>\$ 59,210</u>	<u>\$ 65,498</u>	<u>\$ 78,800</u>	<u>\$ 13,302</u>	<u>20%</u>

SOLAR AND RENEWABLE ENERGY

PHOTOVOLTAIC ENERGY SYSTEMS (Cont'd)

III. Performance Summary - Accomplishments:

Fundamental Research	FY 1997	FY 1998	FY 1999
<p>Measurement & Characterization: 1997 - Supported industry and university research groups in advancing material and cell technologies by characterizing cell materials and devices; and reducing defects in cell materials.</p> <p>1998 - Maintain efforts to assist university and industry researchers characterize cell materials and devices, reduce defects and develop improved cell structures and materials processing through world class facilities at the National Laboratories.</p> <p>1999 - Maintain world-class material characterization capability and continue to provide industry and university researchers assistance in analyzing device structures and materials to reduce defects and improve performance.</p>	\$5,000	\$5,500	\$5,500
<p>Basic Research/University Programs: 1997 - Developed solutions for improved cell structures and materials processing, and developed several new materials and cell structures, including a new transparent conducting oxide (TCO) film for thin-film modules.</p>			

SOLAR AND RENEWABLE ENERGY

PHOTOVOLTAIC ENERGY SYSTEMS (Cont'd)

Fundamental Research (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Basic Research/University Programs: (Cont'd)</p> <p>1998 - Increase support for university research. Develop and characterize new prototype module and cell materials and devices based upon thin-film and crystalline materials; and, advance the understanding of new and novel materials, cell structures, deposition methodologies, semiconductor theory, and measurement and characterization methods and standards. Increase university participation and fund the acquisition of PV test equipment at participating institutions through a competitive procurement of \$1,500,000.</p> <p>1999 - Continue efforts to advance the understanding of new and improved materials, cell structures, deposition processes, semiconductor theory, and characterization methods and standards.</p>			
	\$4,921	\$5,500	\$5,500
TOTAL Fundamental Research	\$9,921	\$11,000	\$11,000
Advanced Materials and Devices			
<p>Thin-Film Partnerships</p> <p>1997 - Achieved new state-of-the-art advances in the scale-up and commercialization of thin-film and crystalline silicon technology for thin-film partnership contracts (19 in total) resulting in 11.5% efficient stabilized amorphous silicon cell (1 cm²) and a 9% stable module (900 cm²); a 9.5% efficient CdTe module; and a 13.5% efficient CIS submodule.</p> <p>1998 - Continue efforts within the thin-film partnership program to accelerate achievement of cost-effective thin-film technologies by awarding 15-20 new industrial and university contracts under the new round of thin Film Partnership solicitations.</p>			

SOLAR AND RENEWABLE ENERGY

PHOTOVOLTAIC ENERGY SYSTEMS (Cont'd)

Advanced Materials and Devices (Cont'd)	FY 1997	FY 1998	FY 1999
Thin-Film Partnerships (Cont'd): 1999 - Increase funding for 4-5 additional Thin-Film Partnership industrial contracts. Achieve 13% efficient stable amorphous silicon cell; 10% stable amorphous silicon modules; and a large increase in the commercial production of 8.5% efficient CdTe thin film modules.	\$15,289	\$16,000	\$19,000
Crystalline Silicon/High Efficiency Devices and Reliability: 1997 - Conducted advanced reliability testing of more than 50 laboratory and commercial cells, modules and balance of system components in support of industry's efforts to extend lifetime warranties on PV modules from the current 10-20 years for commercial products to 20-25 years. Continued research to identify material defects in silicon devices. 1998 - Develop new and improved materials and balance-of-systems components (e.g., an improved, low-cost, highly-stable module encapsulant with potential for greater than 25-year life compared to today's 20-year life). Program will place renewed emphasis on development of super high efficiency tandem junction cells suitable for high ratio concentrator systems. 1999 - Continue reliability improvements of module encapsulants and system components. Continue research on silicon defects and high efficiency devices. Achieve a 32% efficient tandem cell suitable for high concentration.	\$8,000	\$8,000	\$8,000
TOTAL Advanced Materials and Devices	\$23,289	\$24,000	\$27,000

SOLAR AND RENEWABLE ENERGY

PHOTOVOLTAIC ENERGY SYSTEMS (Cont'd)

Collector Research and Systems Development	FY 1997	FY 1998	FY 1999
<p>Manufacturing R&D:</p> <p>1997 - Completed second year of 13 PVMaT Phase 4 contracts that address manufacturing cost reductions, improved efficiency, and improved processing of thin film modules and balance of system components. Issued new solicitations for Phase 5.</p> <p>1998 - Complete third year of three-year Phase 4 contracts to reduce manufacturing costs and improve processing of thin film technologies and balance of system components. Award new Phase 5 three-year contracts that emphasize advanced manufacturing technologies for producing higher performance and lower cost commercial thin film and thin silicon modules.</p> <p>1999 - Fully fund 15-18 new three-year Phase 5 PVMaT contracts (Phase 4 involved 12 contracts). Phase 5 will accelerate cost reductions and capacity additions to help achieve manufacturing cost reductions of 50% from 1996 levels.</p>	\$9,600	\$9,000	\$13,400
<p>Systems Engineering & Reliability:</p> <p>1997 - Continued improving the performance and reliability of balance of system components, with particular attention to new commercial equipment.</p> <p>1998 - Collaborate with U.S. industry to increase system and balance-of-systems efficiency and reliability to achieve additional cost-reduction of about 35% for installed systems in the year 2000 (a savings of about \$2.50 per watt from the present \$8.00 per watt for installed systems) and resulting from improved design, efficiency and quality control.</p>			

SOLAR AND RENEWABLE ENERGY

PHOTOVOLTAIC ENERGY SYSTEMS (Cont'd)

Collector Research and Systems Development	FY 1997	FY 1998	FY 1999
<p>Systems Engineering & Reliability (Cont'd): 1999 - Increase efforts to develop codes, standards and safety specifications for building integrated residential and commercial systems. Continue efforts to evaluate and monitor utility grid tied systems. Maintain reliability research to improve system component performance and reduce O&M costs.</p>	\$12,400	\$12,387	\$14,400
<p>PV Building Opportunities: 1997 - Completed Building Opportunities in the U.S. for Photovoltaics (PV:BONUS) contracts resulting in five new PV products (such as the PV shingle and AC module) that can be integrated into commercial and residential buildings, and assess the projects' results and issue a new solicitation for development of building-integrated photovoltaic product development (PV: BONUS II) and funded 18 contracts.</p> <p>1998 - Assess the performance of installed systems. Complete Phase 1 Concept/Business Plan Development activity for the initial 18 awardees under PV: BONUS II. Select 5-10 awards for the Phase 2 Preliminary Engineering Development solicitation for development of new PV Building Integrated products. Conduct generic technology development research to address technology barriers and industry priorities and needs for expanding market opportunities in the building sector.</p> <p>1999 - Complete Phase 2 Preliminary Engineering Development for PV: BONUS II and initiate Phase 3 Prototype Development/Field Verification by awarding 5-10 PV Building Integrated contracts to industry. Continue R&D on advanced PV Building concepts, tools, and modeling procedures in support of industry efforts for technology development/deployment to address technical barriers to expanded markets for PV in buildings sector. Provide technical support for accelerated use of renewables in as many as one million new buildings by 2010.</p>	\$1,000	\$1,500	\$4,000

SOLAR AND RENEWABLE ENERGY

PHOTOVOLTAIC ENERGY SYSTEMS (Cont'd)

Collector Research and Systems Development (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Climate Change Technology Initiative - Partnerships for Technology Introduction:</p> <p>1997 - Continued construction of the eight projects initiated in FY 1996.</p> <p>1998 - Complete construction of the eight utility grid-tied PV systems under UPVG. Issue new solicitation for projects emphasizing building integrated applications.</p> <p>1999 - No new contracts are planned for FY99. The 10-15 new projects initiated in FY98 emphasizing building integrated applications will be completed and testing and verification activities will be conducted in FY99.</p>	\$3,000	\$2,611	\$2,600
<p>Million Solar Roofs Initiative:</p> <p>1997 - The Million Solar Roofs Initiative was announced on June 26th 1997.</p> <p>1998 - Begin efforts to establish partnerships with state and local governments, energy companies, the solar industry and developers/builders to facilitate installation of solar roof systems. The FY 1998 efforts will be partially funded through the UPVG project. Conduct workshops to provide solar technology training to builders, solar equipment providers and building inspectors.</p> <p>1999 - Increase outreach activities to establish 25 partnerships with energy companies, builders, Federal, and State local agencies, corporations and financial institutions across the nation. Increase training for builders and solar equipment installers. Increase efforts to develop the technology to ensure that PV systems meet requirements of builders and codes and standards.</p>	\$0	\$5,000	\$6,400
TOTAL Collector Research and Systems Development	\$26,000	\$30,498	\$40,800
TOTAL Photovoltaic Systems R&D	\$59,210	\$65,498	\$78,800

SOLAR AND RENEWABLE ENERGY

PHOTOVOLTAIC ENERGY SYSTEMS (Cont'd)

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Fundamental Research:

\$0

Advanced Materials and Devices: Increase funding for 4-5 additional industrial contracts under Thin Film Partnership Programs in order to achieve 13% efficient stable amorphous silicon cells, 10% efficient modules, and boost commercial production of 11% efficient silicon thin film modules.

\$3,000,000

Collector Research and Systems Development: Increase efforts by \$4,400,000 for PVMaT with additional 4-5 new contracts; increase efforts by \$2,000,000 for Systems Engineering and Reliability; increase efforts by \$2,500,000 in PV:BONUS for Phase III building integrated product development contracts; and provide an additional \$1,400,000 for the Million Solar Roofs Initiative.

\$10,302,000

Total Funding Change, Photovoltaics

\$13,302,000

SOLAR AND RENEWABLE ENERGY

SOLAR THERMAL ENERGY SYSTEMS

(Tabular dollars in thousands, Narrative in whole dollars)

I. Mission Supporting Goals and Objectives: The mission of DOE's Solar Thermal Power (STP) Program is to develop economically competitive solar thermal power technologies. Successfully carrying out this mission will *improve* our nations energy security through greater diversity of supply, *reduce* greenhouse gas and other emissions, and *create* business opportunities for U.S. industry both here and abroad, resulting in new high-wage jobs for U.S. workers. Our goal is to work with industry to develop STP technology options that industry can then use to serve both bulk power and distributed power markets. To achieve this goal, we perform advanced component R&D, provide technical assistance, and contribute cost-share for field validation projects with industry in order to facilitate the cost reduction and reliability improvements needed for commercial readiness.

Today, there are three STP technology options: power towers and parabolic troughs (bulk power) and dish/engine systems (distributed power). These systems can be sized from 200MW (towers and troughs) to 20kW (dish/engine). Some STP systems utilize thermal storage to put “sun in a bottle” for use during cloudy periods or at night, while others can be hybridized to provide high-value dispatchable power. These attributes, along with world record solar-to-electric conversion efficiencies (29.4%), make solar thermal power a very attractive renewable energy option in the U.S. Southwest and sunbelt regions around the world.

Recent state initiatives, such as California’s AB1890, the portfolio standard requirements for Arizona and Nevada, and an RFP to be issued in New Mexico, have opened up near-term domestic opportunities for renewable energy. Utilities, such as Arizona Public Service, which place a high-value on dispatchability and peak-shaving power options, see solar thermal electric technologies as leading candidates to provide a significant portion of this power. Internationally, India, Brazil, Mexico, and Egypt have plans to develop multi-megawatt solar thermal plants in the near term with plans for multi-gigawatt plants over the long term. Many other countries are examining solar thermal power development. These opportunities could develop into huge export markets for U.S. industry. The results of these efforts will be to provide economic stimulus creating high-wage U.S. jobs, increase U.S. security through diversity of energy supply, and reduce CO₂ and other emissions in support of the Climate Change Technology Initiative.

SOLAR AND RENEWABLE ENERGY

SOLAR THERMAL ENERGY SYSTEMS (Cont'd.)

I. Mission Supporting Goals and Objectives (Cont'd.):

A. Estimates of Benefits At the proposed funding levels, the STP Program is expected to yield the following quantifiable benefits:

	2000	2010	2020
-----	-----	-----	-----
Annual Primary Energy Displaced (Quads)	0.00	0.01	0.04
Carbon Equivalent Emission Reduction (MMT)	0.02	0.15	0.53

Current projections are that within the next five years, solar thermal power will be available at 9¢/kWh for bulk power systems and 12¢/kWh for distributed systems. It is estimated that between 50 and 100MW of new solar thermal power systems will be installed by the year 2003, subject to varying market conditions.

B. Performance Measures (highlights) The following performance measures will be used by the Solar Thermal Program to track its commitment to help bring these technologies into the marketplace:

FY 1997 Performance Measures

- Deployed two 25-kW dish/engine systems at utility and user sites in the U.S. Southwest in order to validate design and performance.
- Achieved full-rated 10MW of power output at Solar Two power tower in California and demonstrated 3 hour operation after sunset.
- Built and deployed two SolMaT Phase II heliostats for on-sun testing.

SOLAR AND RENEWABLE ENERGY

SOLAR THERMAL ENERGY SYSTEMS (Cont'd.)

I. Mission Supporting Goals and Objectives (Cont'd.):

FY 1998 Performance Measures

- Deploy a minimum of two additional 25-kW dish/engine systems at utility and user sites in the U.S. Southwest. Log 750 hours of automated operation on a single dish/engine unit in the field.
- Achieve 90% system availability at Solar Two and produce 1,500 MW-Hrs of electricity for a one month period.
- Build and deploy two additional SolMaT Phase II heliostats at a utility site in U.S. Southwest for on-sun testing.

FY 1999 Performance Measures

- Install 20 manufacturing prototype and four advanced prototype 25-kW dish/engine solar thermal systems at utility/field sites through the Utility Scale Joint Venture Program.
- 1000 Hrs mean time between failures for 5 dish/engine systems in unattended operation.
- 30¢/kWh levelized energy cost for distributed (using dish/engine technology) power systems.
- 16% average efficiency for distributed power systems; 11.5% average efficiency for bulk power systems.
- Plans for first 30MW bulk solar power project finalized.

FY 2000 - 2005 Performance Measures

- Annual addition of 10 MW of new installed capacity for distributed power systems.
- Construction of first utility-scale bulk power systems (30 to 50MW).
- \$4,000/kW installed cost for distributed power system; \$2,500/kW installed cost for bulk power systems.

SOLAR AND RENEWABLE ENERGY

SOLAR THERMAL ENERGY SYSTEMS (Cont'd.)

I. Mission Supporting Goals and Objectives (Cont'd.):

- 22% annual efficiency for distributed power systems; 13% annual efficiency for bulk power systems.
- 12¢/kWh levelized energy cost for distributed power system; 9¢/kWh levelized energy cost for bulk power systems.
- Reduce the cost of heliostats from \$170/m² to \$120/m².

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
Solar Thermal Electric R&D					
Thermal Systems Research	\$ 8,387	\$ 6,150	\$ 5,500	\$ -650	-11%
Power Applications Research	<u>13,537</u>	<u>10,369</u>	<u>17,000</u>	<u>6,631</u>	<u>64%</u>
Total, Solar Thermal Energy Systems	<u>\$ 21,924</u>	<u>\$ 16,519</u>	<u>\$ 22,500</u>	<u>\$ 5,981</u>	<u>36%</u>

SOLAR AND RENEWABLE ENERGY

SOLAR THERMAL ENERGY SYSTEMS (Cont'd.)

II. Performance Summary - Accomplishments:

Solar Thermal Electric R&D - Thermal Systems Research	FY 1997	FY 1998	FY 1999
<p>Thermal Systems Research:</p> <p>1997 - Entered 3rd year of optical materials outdoor acceptance test program. Initiated testing of stretched-membrane heliostats at Solar Two. Installed first-generation hybrid (solar/natural gas) reflux receivers on 25-kW dish/Stirling systems for field testing. Continued Solar Two technical support and research related to molten-salt receiver. Continued life-cycle testing of Stirling and Brayton dish/engine systems on-sun. Initiated long-term R&D projects.</p> <p>1998 - Enter 4th year of optical materials outdoor acceptance test program. Complete validation of hybrid reflux receivers for commercial applications. Continue Solar Two technical support and research related to molten-salt receivers. Complete life-cycle testing of Stirling and Brayton dish/engine systems on-sun. Complete validation test of advanced dish/engine system for commercial applications. Continue systems research and long-term R&D efforts.</p> <p>1999 - Complete 5-year optical materials outdoor acceptance test program. Validate power tower and dish/engine hardware; assist industry in developing and demonstrating reliable solar thermal systems and components with acceptable O&M costs; support power tower testing and evaluation; assist industry in developing and demonstrating hybrid molten-salt power tower components; and develop advanced STP concepts/components; identify and develop advanced materials for solar applications.</p>			
	\$8,387	\$6,150	\$5,500
TOTAL Solar Thermal Electric R&D - Thermal Systems Research	\$8,387	\$6,150	\$5,500

SOLAR AND RENEWABLE ENERGY

SOLAR THERMAL ENERGY SYSTEMS (Cont'd)

Solar Thermal Electric R&D - Thermal System Research (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Dish/Engine Development:</p> <p>1997 - Dish/engine manufacturer contracted with utility partners to purchase and install two 25-kW units. These second generation systems incorporated design changes to improve performance and reliability.</p> <p>1998 - Build and install a minimum of two additional 25-kW dish/engine systems. Log 750 hours of “continuous” automated operation on a single dish/engine unit in the field.</p> <p>1999 - Under Phase III of the Utility-Scale Joint Venture Project (USJVP), initiate the field installation of advanced dish/engine systems to achieve improved system performance and reliability. These units will demonstrate the technology in different user environments and configurations in the U.S. Southwest. Under Phase II of the Dish/Engine Critical Components (DECC) Initiative, assist at least one developer in integrating critical components into an alternative dish/engine system. Perform testing and field evaluation.</p>	\$4,300	\$4,870	\$6,400
<p>Dish/Engine Field Verification Initiative:</p> <p>1997 - No activities.</p> <p>1998 - No activities.</p> <p>1999 - This cost-shared, MW-scale, dish/engine initiative will allow industry, with technical support from the national laboratories, to install, test, and verify systems in a utility environment; establish long-term system reliability; quantify O&M issues and costs; and develop the manufacturing capability and production capacity necessary to build future systems that will begin to compete economically in the distributed power market.</p>	\$0	\$0	\$3,000

SOLAR AND RENEWABLE ENERGY

SOLAR THERMAL ENERGY SYSTEMS (Cont'd)

Solar Thermal Electric R&D - Thermal System Research (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Power Tower Development: 1997 - Completed acceptance test and evaluation phase and initiate the power production phase of Solar Two.</p> <p>1998 - Establish routine operations at Solar Two. Optimize plant performance, and establish the technical and operational feasibility of future commercial power tower plants.</p> <p>1999 - Support second year of routine testing and operations at Solar Two. Optimize plant performance, and establish the technical and operational feasibility of future commercial power tower plants.</p>	\$4,520	\$3,200	\$3,200
Solar Thermal Electric R&D - Power Applications Research			
<p>SolMaT Initiative: 1997 - Fabricated and deployed heliostats and advanced state-of-the-art power tower receiver panels for manufacturing validation. Completed the manufacturing evaluation of a composite dish/engine concentrator.</p> <p>1998 - Install advanced heliostats and state-of-the-art power tower receiver panels at Solar Two for evaluation in a utility environment. Build composite dish/engine concentrator for manufacturing validation.</p> <p>1999 - Expand activities to include drive mechanisms for dishes and heliostats. Install composite dish/engine concentrator for field validation.</p>	\$1,930	\$220	\$2,200

SOLAR AND RENEWABLE ENERGY

SOLAR THERMAL ENERGY SYSTEMS (Cont'd)

Solar Thermal Electric R&D - Power Applications Research (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Systems and Markets/Industrial Assistance:</p> <p>1997 - Supported U.S. industry to evaluate and capitalize on near-term domestic and international opportunities for trough and power tower systems. Assisted industry efforts to reduce the O&M and manufacturing costs of solar thermal systems. Provided support for the California Energy Commission Initiative for six renewable energy prison heating systems.</p> <p>1998 - Assist U.S. industry to evaluate and capitalize on near-term domestic and international opportunities for trough and power tower systems. Assist industry efforts to reduce the O&M and manufacturing costs of solar thermal systems.</p> <p>1999 - Assist industry in developing and demonstrating reliable solar thermal systems and components with acceptable O&M costs. Provide additional technical assistance to U.S. industry as hardware moves from the laboratory to the field.</p>			
	\$2,787	\$2,079	\$2,200
TOTAL Solar Thermal Electric R&D - Power Applications Research	\$13,537	\$10,369	\$17,000
TOTAL Solar Thermal Energy Systems	\$21,924	\$16,519	\$22,500

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Thermal Systems Research: The decrease of \$650,000 eliminates funding for optical materials, and reduces funding for advanced R&D, concentrator and dish technology research in FY 1999. This would allow additional funds to be applied to the area of dish/engine system reliability, which is a critical need identified by industry.

\$-650,000

SOLAR AND RENEWABLE ENERGY

SOLAR THERMAL ENERGY SYSTEMS (Cont'd)

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999 (Cont'd):

Power Application Research: The increase of \$6,631,000 includes:

\$6,631,000

Dish/Engine Development - An increase of \$1,530,000 to assist a second U.S. dish/engine team in developing advanced, critical dish/engine components, and initiate field validation. This will allow a second dish/engine development path to be developed, providing additional options as the technology progresses.

Dish/Engine Field Verification - An increase of \$3,000,000 to fund a new initiative to cost-share a MW-scale, dish/engine installation, which will allow industry to install, test, and evaluate systems in utility/generator/user environments; establish long-term system reliability; quantify O&M issues and costs; and develop the manufacturing capability and production capacity necessary to build future systems that will begin to compete economically in the distributed power market.

Power Tower Development - Level funding for Solar Two support, as it enters the second year of routine testing and operations.

SolMaT - An increase of \$1,980,000 supports additional research into the economic manufacturing of reliable drive systems and the field validation of a composite concentrator.

Systems and Markets/Industrial Assistance - An increase of \$121,000 will provide O&M support for the U.S. solar thermal industry as the number of systems in the field increases and provide research to ensure the reliability of solar thermal systems.

Total Funding Change, Solar Thermal Energy Systems

\$5,981,000

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS

(Tabular dollars in thousands, Narrative in whole dollars)

I. Mission Supporting Goals and Objectives: Biomass energy serves two major energy sector markets, electric power and transportation. The mission of the Biopower/Biofuels Energy Systems Program is to assist U.S. industry in developing the technology base necessary for deploying cost-competitive renewable biomass energy systems capable of capturing these energy market opportunities. In support of this mission, the program pursues the development of low cost biomass energy feedstocks and cost competitive, highly efficient conversion technologies for power generation and liquid fuels production. Biomass feedstocks consist of a wide range of plant-based matter, including agricultural residues (e.g., rice straw/husks, bagasse, and forestry wastes, e.g., sawdust), trees and crop materials and grasses grown specifically for use as energy feedstocks.

Biomass energy systems provide substantial environmental benefits. Since bioenergy crops absorb carbon during growth, their use for transportation fuels or electricity generation results in near zero net carbon release. When these fuels are used to displace traditional fossil fuels, significant emission reductions of greenhouse gas emissions can therefore be achieved. In addition, since biomass is domestically produced and is renewable, it offers significant opportunities for job creation, rural economic development, and alternative crop production opportunities for farmers (which can result in reduction of federal agricultural subsidy payments).

BIOPOWER ENERGY SYSTEMS - OFFICE OF UTILITY TECHNOLOGIES

The mission of the Biopower Program is to encourage and assist the development and validation of renewable, biomass-based electricity generation systems which are capable of providing substantial economic and environmental benefits to the nation. The goals of the program are to: (1) advance the state-of-the-technology to a point where integrated biomass power systems (systems that integrate the production of high yielding feedstocks with advanced power conversion technologies) are cost-competitive with conventional fossil-fuel options, (2) enable an advanced turbine system to be adaptable to biomass-derived fuels, (3) develop systems capable of capturing emerging opportunities in international markets, and (4) support industry efforts to demonstrate these technologies through highly leveraged, cost-shared projects.

Biomass power is an attractive renewable electricity option for several reasons: 1) it is available upon demand for high-value baseload and intermediate-load power generation applications; 2) it can serve as a vital economic stimulus and create jobs in rural America through the creation of markets for renewable "home-grown" energy crops; and 3) it provides significant reduction in greenhouse gas

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

emissions and increased fuel diversification. In order to capture these opportunities and to produce electricity from biomass in a cost-competitive manner, the Biopower Program champions critical biomass power research, development, and proof-of-concept activities.

Specific program goals include conducting the necessary research and development activities which will enable integrated biomass power systems to produce electricity for 4-1/2 to 5 cents/kilowatt-hour (the current cost is 7-9 cents/kilowatt-hour). Cost-shared gasification research is being conducted with industry partners and is aimed at capturing near-term domestic and international opportunities in this highly competitive market. The collaborative DOE/USDA "Biomass Power for Rural Development" initiative provides for cofiring, gasification and/or direct combustion cost-shared project opportunities with both agriculturally-based consortia and other key industry partners (including the pulp-and-paper industry). Research and analysis will be conducted on issues associated with integration of biomass power systems into a restructured increasingly competitive electric utility industry framework. Fundamental research on resource characteristics will also identify cost-competitive options for systems integration. The modular systems development activities for small-scale systems (up to 5 MW) help to ensure a competitive U.S. industry presence as the global need for small systems grows.

The goal of the Advanced Turbine Systems (ATS)/Biomass for Cogeneration project is to allow biomass derived fuels to be burned in a combustion turbine. Switching from natural gas to biomass fuels in combustion turbines is an important opportunity and a significant challenge. The biomass derived fuels contain corrosive species which rapidly degrade gas turbine performance. Cogeneration is the efficient production of two forms of energy (electricity and steam) from the same fuel source using the exhaust from one system as the input for the other. Cogeneration system efficiencies can reach as high as 90%, significantly higher than when the production of steam and electricity are separated. To reach the goal requires development in two critical areas: gas clean-up and ruggedizing the turbine to improve corrosion and erosion resistance.

A. Estimates of Benefits

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

The currently installed domestic biomass power generating capacity stands at approximately 7,000 MW. It is expected that by 2000, up to an additional 1,000 MW of biomass power systems will be installed. By 2010, it is predicted that 8,000 MW of new biomass power capacity will be added, growing to a total of 30,000 MW of newly installed capacity by 2020. This growth will be experienced in worldwide market segments, including biomass cofiring at existing coal-fired facilities, greatly increased energy from repowering within the pulp and paper industry, new integrated biomass power system deployments in rural areas aimed at capturing crucial economic and environmental benefits afforded by these systems, and deployments of smaller-scale, modular biopower systems in the international marketplace. This dramatic growth will be facilitated by the development and demonstration of high-efficiency, advanced technology biomass power systems which will be achieved in the first decade of the next century. The following table summarizes the biomass power program's benefits; these are cumulative benefits assuming a baseline of zero in 1998:

Metric	2000	2010	2020
Annual Primary Energy Displaced (Quads)	.06	.58	1.2
Carbon Equivalent Emissions Reductions (MMTons)	1.3	14	28

In general, Cogeneration systems for power and steam generation will be more cost-effective, more efficient, and environmentally cleaner than conventional, separated systems. Advanced Turbine Systems (ATS) cogeneration system efficiencies can reach as high as 90%. The metrics summarized below are elements of the use of biomass in Cogeneration applications; these are cumulative benefits assuming a baseline of zero in 1998:

Metric	2000	2010	2020
Total Primary Energy Displaced (Trillion Btus)	.27	62	79
Energy Cost Savings (\$B)	.03	.06	.08
Carbon Reduction (MMTons)	.57	1.3	1.7

B. Performance Measures

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

Research and development advances sponsored by the Biopower Program will be incorporated into biomass electric conversion technologies enabling cost-competitive electricity production using dedicated energy feedstocks by 2004. The Biomass for Cogeneration program will demonstrate a combustion turbine that will be adaptable to biomass-derived fuels in 2000. In FY 1999, complete 5 commercial-scale demonstrations of the use of biofuels in power-plants by co-firing and with at least 5 percent biomass.

BIOFUELS ENERGY SYSTEMS - OFFICE OF TRANSPORTATION TECHNOLOGIES

The strategic advantage of the Transportation Biofuels program is that it addresses several extremely important issues at the local, regional, national and international levels. Reductions of oil imports, greenhouse gas emissions, urban air pollution, forest fire potential, and balance of trade deficit can be achieved simultaneously with the creation of jobs in rural America. Biofuels are a significant component in the Department's energy strategy to insure meaningful energy diversity. Biofuels are the only transportation renewable energy technologies pursued by the Department which create transportation fuel products that can be blended with gasoline and diesel fuels. Biofuels produce almost no net carbon on a life cycle basis, since the carbon emitted into the atmosphere is used by trees and grasses (biomass) for growth. The Department's Office of Policy, in conjunction with the Biofuels Program, is evaluating the option of blending ethanol with gasoline as a greenhouse gas mitigation strategy for reducing greenhouse gases and other air emissions by the year 2005-2010 time frame. The potential for transportation biofuels to reduce carbon emissions is 12-16 million metric tons annually by 2010.

Transportation Biofuels' research, development and demonstration activities focus on integrated biomass feedstock production and conversion systems for the production of ethanol. The demonstration activities for ethanol will involve testing with an industrial partner in an industry owned facility. In the near-term, major program activities include research and technology development to produce ethanol from waste materials, such as corn fiber, rice straw, and forestry waste, to be blended into gasoline for oxygenated fuel markets. The near-term use of waste feedstocks can expand the current starch-based ethanol industry, serving as a logical transition from starch to cellulose feedstocks. Environmental air quality problems from the burning of rice straw or catastrophic forest fires have been experienced recently in the western U.S., serve as ethanol deployment opportunities, if various private and other government partners are willing to pay for the environmental and other benefits. Catastrophic forest fire (biomass) burning releases tremendous amounts of greenhouse gases and noxious fumes into the troposphere. Ethanol production from the softwoods accumulated from thinning National Forests would reduce the potential of these fires.

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

In the mid- to long-term, commercially-viable energy crops, such as hybrid poplar and switchgrass, which are under development by the program, will be used to produce ethanol for use in flexible fueled or dedicated alternative fuel vehicles. Energy crops have advantages from an environmental perspective in terms of carbon recycling and sequestration, erosion control compared to traditional agricultural row crops, and the potential for using marginal agricultural land to expand the agricultural base in the United States. Biofuels feedstock production and conversion research and development activities are coordinated with the U.S. Department of Agriculture.

Mid-term Biofuels research efforts for ethanol are being coupled with the Department's fuel cell program, which is funded as part of the Partnership for a New Generation of Vehicles managed by the Office of Advanced Automotive Technologies in EERE. This attractive pairing of a renewable-based fuels technology with an extremely efficient (80 miles per gallon goal) vehicle technology has tremendous potential benefits in terms of greenhouse gas reductions, oil import reduction, and conservation of our natural resources.

Biofuels research efforts to lower costs of biodiesel, and to develop and test new fuel formulations, are also strategically linked with work sponsored by the Office of Heavy Vehicle Technologies. For example, diethyl ether (DEE) made from ethanol is a fuel that will be evaluated for its application to heavy vehicles. DEE's high cetane number and other fuel properties make it potentially attractive to heavy vehicle use.

The Regional Biomass Energy Program will have a significant role in an aggressive plan for the deployment of biomass-based technologies. The program, through its local and regional contacts, will transfer current and reliable information on biomass development activities to potential users; this includes economic and technical information as well as state and local regulatory, environmental and market considerations.

A. Estimates of Benefits

Metric	2000	2010	2020

Primary Energy Displaced (Quads)	0.0	0.68	1.01
Primary Oil Displaced (MBPD)	0.0	0.32	0.48

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

Energy Cost Savings (\$B)	0	0.0	0.0
Carbon Reductions (MMTons)	0	13	20

B. Performance Measures

The Biofuels Program has established ethanol production cost goals that drive research and technology development activities, and are related to the performance measures listed below. By the year 2000, the goal is to demonstrate technologies, in collaboration with industry partners, capable of producing ethanol from low-cost cellulosic waste materials at a cost of \$0.90 per gallon, using biochemical conversion technology. In FY 1999, the program will support an industrial partner to begin construction of an industry-owned facility to demonstrate a first-of-a-kind cellulosic biomass to ethanol technology from agricultural crop wastes. By 2010, the goal is to produce ethanol in production volume plants at a cost of \$0.67 per gallon from energy crops, and by 2020, to produce ethanol at a cost of \$0.60 per gallon. The production cost goals are shown in the following table:

	Cost Parameters Biofuels-Transportation**						
	1985	1996	1997	1998	2000	2010	2020

----- Ethanol cost \$/gallon*	3.80	1.22	1.20	1.13	0.90	0.67	0.60

* Based on feedstock cost of \$2.00/MMBTU

** Based on constant 1997 dollars

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
Biopower Energy Systems - Utilities					
Thermochemical Conversion	\$ 1,272	\$ 1,500	\$ 2,700	\$1,200	80%
Systems Development	18,262	21,392	37,300	15,908	74%
Biomass for Cogeneration	3,953	2,564	2,900	336	13%
Feedstock Production	2,100	1,723	0	-1,723	-100%
Regional Biomass Energy Program	<u>1,575</u>	<u>985</u>	<u>0</u>	<u>-985</u>	<u>-100%</u>
Total Biopower Energy Systems	\$ 27,162	\$ 28,164	\$ 42,900	\$ 14,736	52%
Biofuels Energy Systems - Transportation					
Ethanol Production	\$ 22,165	\$ 25,426	36,391	10,965	43%
Biodiesel Production	750	750	1,000	250	33%
Feedstock Production	2,500	2,500	6,000	3,500	140%
Regional Biomass Energy Program	<u>1,750</u>	<u>2,000</u>	<u>3,500</u>	<u>1,500</u>	<u>75%</u>
Total, Biofuels Energy Systems	\$ 27,165	\$ 30,676	\$ 46,891	\$ 16,215	53%
Total, Biopower/Biofuels Energy Systems . . .	<u>\$ 54,327</u>	<u>\$ 58,840</u>	<u>\$ 89,791</u>	<u>\$ 30,951</u>	<u>53%</u>

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

III. Performance Summary - Accomplishments:

Biopower Energy Systems - Utilities - Thermochemical Conversion	FY 1997	FY 1998	FY 1999
<p>1997 - Completed de-coupled testing, establish cleanup requirements and confirm simple cycle efficiencies for gasification/fuel cell systems; completed market assessment for biomass gasifier/fuel cell systems; investigated biomass gasification products using time-of-flight mass spectrometer; continued investigation of coal/biomass blend combustion with respect to alkali release and pollutant formation, coordinated results and efforts with Fossil Energy programs; continued investigation of alkali and nitrogen chemistry as it relates to biomass combustion.</p> <p>1998 - Continue detailed analytical investigations in support of industry-related biomass combustion/cofiring and gasification activities in collaboration with other government laboratories. Initiate efforts for developing efficient energy feedstock handling systems, including improved harvesting techniques.</p> <p>1999 - Perform laboratory-based research on: fuel cell and Stirling engine integration with gasification systems; biomass handling systems; hot gas clean-up; and ash deposition mitigation/handling and analysis.</p>			
TOTAL Biopower Energy Systems - Utilities - Thermochemical Conversion	\$1,272	\$1,500	\$2,700

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

Biopower Energy Systems - Utilities - Systems Development	FY 1997	FY 1998	FY 1999
Climate Change Technology Initiative- Hawaii Direct Gasifier Project: 1997 - Incorporated a full-scale Hot-Gas Cleanup unit into the facility. 1998 - Complete project close out. 1999 - No project activity.	\$4,096	\$600	\$0
Climate Change Technology Initiative- Vermont Indirect Gasifier Project: 1997 - Completed Phase II of the project, which included plant construction. 1998 - Complete Phase IIIa of the project which includes operational testing of the gasifier and conducting output gas analysis. 1999 - Using prior year funds complete the project (Phase III), which includes installation of a commercially available gas turbine, and conducting integrated testing/operation of the gasifier/gas turbine configuration, leading to commercial operation.	\$5,393	\$1,550	\$0
Climate Change Technology Initiative - Biomass Power for Rural Development Initiative (New York Willow Project, Iowa Switchgrass Project, Minnesota Valley Alfalfa Producers Project): 1997 - Completed Phase I (detailed design engineering and permitting) and initiate establishment of dedicated energy crop supplies for at least three of these integrated biopower facilities. Power plant modifications for energy crop utilization were initiated at two cofiring project sites.			

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

Biopower Energy Systems - Utilities - Systems Development (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Climate Change Technology Initiative (Cont'd) - 1998 - Facility construction for co-firing projects and energy crop establishment will continue (total biopower capacity at these project sites will exceed 150 MW). Cofiring tests of willow energy crops with coal in a commercial application will be accomplished.</p> <p>1999 - Minnesota Valley Alfalfa Producers Project (the largest project and a new facility) will be in the construction phase. Full operation, full capacity testing and technology verification will begin in the other projects.</p>	\$8,773	\$17,742	\$20,000
<p>Co-firing Biomass with Coal Initiative: 1997 - No activities</p> <p>1998 - This co-firing initiative has two goals: 1) to prove the commercial viability of co-firing in coal boilers by providing technical and financial assistance for co-firing projects; and 2) to accelerate the adoption of co-firing by additional utilities by initiating a concentrated technology transfer initiative which will include the analysis and informational tools to help electricity generators gain acceptance of, plan for, and implement suitable biomass co-firing projects. With our federal and industry partners, we will develop plans for accelerating the pace of adoption of co-firing by large grid-connected coal utilities. Co-funding field validation of biomass co-firing in several coal boilers will begin. Analysis of efficiency and emission results and methods for optimizing system performance will begin.</p>			

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

Biopower Energy Systems - Utilities - Systems Development (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Co-firing Biomass with Coal Initiative (Cont'd): 1999 - Co-funding of field validation projects will be expanded. Useful information about all aspects of implementing biomass co-firing projects will be shared in a variety of formats for a variety of stakeholders. Tools to help with project implementation such as identifying low-cost feedstock supplies, and project planning, will be developed, reality tested and shared. Complete 5 commercial-scale demonstrations of the use of biofuels in power-plants by co-firing and with at least 5 percent biomass.</p>	\$0	\$0	\$9,300
<p>Modular Systems Development: 1997 - No activities.</p> <p>1998 - Building on advancements achieved through prior year thermochemical conversion development research in this area, initiate efforts with U.S. industry aimed at developing modular (5 kW -5 MW) biopower systems for distributed generation and remote power applications. Cost-shared development of smaller biopowered systems (such as Stirling engines and fuel cells) will support U.S. industry capture of rapidly expanding global market opportunities.</p> <p>1999 - Funded projects will begin to meet their small modular biopower system development goals as outlined in the solicitation. Pilot systems are expected to begin the construction phase.</p>	\$0	\$1,500	\$8,000
TOTAL Biopower Energy Systems - Utilities - Systems Development	\$18,262	\$21,392	\$37,300

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

Biopower Energy Systems - Utilities - Biomass for Cogeneration	FY 1997	FY 1998	FY 1999
ATS/Biomass for Cogeneration: 1997 - Continued development of thermal barrier coatings and improved airfoil castings. 1998 - Continue design and testing of combustion turbine components 1999 - Continue to analyze the gasification and combustion products of low/medium Btu fuels.			
TOTAL Biopower Energy Systems - Utilities - Biomass for Cogeneration	\$3,953	\$2,564	\$2,900
Biopower Energy Systems - Utilities - Feedstock Production			
1997 - Feedstock production research in FY 1997 was co-funded by Biopower-Utilities and Biofuels-Transportation in accordance with Congressional report language. Activities for FY 1997 through FY 1998 support a core program that is designed to meet the needs of both programs. Since this core program is managed by Biofuels-Transportation, the program activity description is contained in that request. 1998 and 1999 - The program activity description is contained within the Biofuels-Transportation budget, which manages this activity.			
TOTAL Biopower Energy Systems - Utilities - Feedstock Production	\$2,100	\$1,723	\$0

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

Biopower Energy Systems - Utilities - Regional Biomass Energy Program	FY 1997	FY 1998	FY 1999
<p>1997 - Regional Biomass Energy Program activities in FY 1997 were co-funded by Biopower-Utilities and Biofuels-Transportation in accordance with Congressional report language. Activities for FY 1997 through FY 1998 support a core program that is designed to meet the needs of both programs. Since this core program is managed by Biofuels-Transportation, the program activity description is contained in that request.</p> <p>1998 - The program activity description is contained within the Biofuels-Transportation budget, which manages this activity.</p> <p>1999 - The program activity description is contained within the Biofuels - Transportation budget, which manages this activity.</p>			
TOTAL Biopower Energy Systems - Utilities - Regional Biomass Energy Program	\$1,575	\$985	\$0
TOTAL Biopower Energy Systems - Utilities	\$27,162	\$28,164	\$42,900
Biofuels Energy Systems - Transportation - Ethanol Production			
<p>Advanced Fermentation Organisms R&D: 1997 and 1998 - Conduct research and development of advanced fermentation organisms to improve process efficiency, including the development of Zymononas Mobilis with enhanced capabilities.</p> <p>1999 - Continue R&D of advanced fermentation organisms to operate on mixed sugars from waste feedstocks and switchgrass with increased stability and robustness; re-initiate development of promising Lactobacillus, which was delayed in 1997.</p>			
	\$2,000	\$1,960	\$2,000

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

Biofuels Energy Systems - Transportation - Ethanol Production (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Advanced Cellulases R&D: 1997 - Conducted research and development of advanced engineered cellulases and expression systems, including but not limited to genetic engineering of Streptomyces lividans to produce the third cellulase enzyme, leading to the development of an artificial cellulase system.</p> <p>1998 - Continue R&D; establish one partnership with cellulase producers to develop highly productive, low-cost cellulase systems.</p> <p>1999 - Continue R&D of highly productive, low-cost cellulase systems; complete conceptual design of on-site cellulase production technology and initiate demonstration of on-site cellulase technology.</p>	\$2,100	\$2,455	\$5,000
<p>Pretreatment R&D: 1997 - Completed design and initiate scale-up of an advanced pretreatment reactor, with an industrial partner.</p> <p>1998 - Incorporate/modify the National Renewable Energy Laboratory (NREL) process development unit (PDU) to include the advanced pretreatment reactor.</p> <p>1999 - Conduct bench scale testing of cost-effective pretreatment technology for softwood feedstocks and potential co-products, to improve process economics. Complete modifications and initiate testing of countercurrent pretreatment reactor.</p>	\$2,000	\$1,960	\$5,008

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

Biofuels Energy Systems - Transportation - Ethanol Production (Cont'd)	FY 1997	FY 1998	FY 1999
Consortium for Plant Biotechnology Research: 1997, 1998 and 1999 - Conduct 50:50 cost-shared, long term R&D projects with the Consortium for Plant Biotechnology Research, which provides high-quality, peer-reviewed university research with practical application to biofuels development.	\$1,100	\$2,455	\$1,000
Integrated Process Development: 1997 and 1998 - Conduct integrated bench-scale studies to evaluate and optimize unit operations, such as detoxification studies, to improve the overall process. 1998 - Validate at the bench scale the performance of a genetically improved fermentation organism capable of fermenting available sugars. 1999 - Conduct integrated bench-scale studies to evaluate performance of overall process; conduct integrated bench-scale tests of softwood thinnings from private and public forests, including National Forests, in cooperation with industrial partners. 1997, 1998 and 1999 - Operate the NREL process development unit (PDU) in a fully integrated mode (feedstock to ethanol) with one or more partners (1997 - Swan Biomass, Inc., 1998 - BC International; 1999 - TBD), testing all unit operations (handling, pretreatment, fermentation) to evaluate process efficiency and costs for agricultural waste feedstocks, such as rice straw; and test softwood feedstocks at the NREL biofuels user facility/PDU.	\$8,535	\$8,690	\$11,000
Feasibility Studies: 1997 and 1998 - Provide technical and financial support for feasibility studies/business plans with industrial partners for biomass-to-ethanol production facilities. 1999 - All technical and financial support for cellulosic biomass-to-ethanol facilities will continue under the next Activity : “ Cellulose to Ethanol Production Facilities. ”	\$1,430	\$841	\$0

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

Biofuels Energy Systems - Transportation - Ethanol Production (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Cellulose-to-Ethanol Production Facilities: Laying the groundwork for a broad based cellulosic biomass-to-ethanol industry, develop cost-shared partnerships to design and construct ethanol production facilities.</p> <p>1997 - Established one additional partnership for a waste-to-ethanol facility, (BC International (BCI) cane bagasse waste in Louisiana), with the DOE share \$2,000,000 and BCI projected to provide \$6,200,000 or 76% cost share. Gridley rice straw demonstration which is a 50%/50% cost-shared project for a rice straw demonstration facility with DOE (FY 1996 funding of \$800,000 and FY 1997 funding of \$2,450,000). In related project work, a Phase I pre-feasibility project neared completion.</p> <p>1998 - Obtain an additional commitment to design and construct biomass waste to ethanol facilities. BC International will complete funding for the project that was initiated in FY 1997. DOE's share in FY 1998 is planned at \$4,000,000, with BCI cost-share of \$27,600,000, or 87%. The additional commitment is expected to come from among a number of potential companies/waste opportunities including Swan Biomass Company, Arkenol, Quincy Library Group, and Masada Resources Group. Additional \$750,000 included in the Biomass Power total for the Gridley Project. A minimum 50% cost share will be required from any partner entering into an agreement.</p> <p>1999 - Continue support of commitment initiated in 1998. Establish additional commitment with industry partners that will lead to the design and construction of commercial demonstration facilities in targeted areas: California, Alaska and Utah.</p>			
	\$5,000	\$7,065	\$12,383
TOTAL Biofuels Energy Systems - Transportation - Ethanol Production	\$22,165	\$25,426	\$36,391

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BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

Biofuels Energy Systems - Transportation - Biodiesel Production	FY 1997	FY 1998	FY 1999
<p>Biodiesel Production Technologies: 1997 and 1998 - Based on a completed assessment, identify and implement strategies for improving the potential of biodiesel fuel. Work with biodiesel industry organizations to facilitate market penetration.</p> <p>1999 - Continue to improve biodiesel process technology, utilizing waste grease streams to lower production costs; Continue to work with biodiesel industry. Begin to evaluate potential of improved oilseed production to lower biodiesel production costs.</p>	\$550	\$550	\$1,000
<p>Waste Oil Assessment: 1997 and 1998 - Conduct an evaluation of the quantity, availability, and potential of waste oils as a transportation fuel.</p> <p>1999 - Assessment completed in 1998.</p>	\$200	\$200	\$0
TOTAL Biofuels Energy Systems - Transportation - Biodiesel Production	\$750	\$750	\$1,000
Biofuels Energy Systems - Transportation - Feedstock Production *			
<p>Biomass Feedstock Development Centers: 1997 and 1998 - Conduct research to develop economically viable model energy crops at integrated biomass feedstock development centers in the Pacific Northwest (poplars), Southeast (switchgrass), and Midwest/Plains States (switchgrass and poplars)</p>			

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BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

Biofuels Energy Systems - Transportation - Feedstock Production (Cont'd) *	FY 1997	FY 1998	FY 1999
Biomass Feedstock Development Centers (Cont'd): 1997 and 1998 - Conduct research to develop willow as a viable energy crop in the Northeast/Lake States. 1999 - Continue to support integrated regional development centers where breeding work to select for higher yields and other desirable traits is linked closely with studies on management, physiology, growth-limiting factors, and advanced biotechnology.	\$3,300	\$3,300	\$4,500
Switchgrass/Ethanol Facilities Location Studies: 1997 - Conducted an analysis to determine the number of ethanol facilities that could be supported in the Southeast and Midwest/Plains States.	\$100	\$0	\$0
Environmental Effects of Energy Crop Deployment: 1997 and 1998 - Conduct research to evaluate the effects of large scale deployment of energy crops on the environment, and to provide credible data that can be used to guide deployment in a manner that ensures energy and environmental benefits. 1999 - Continue to evaluate established experimental sites for water and soil quality effects, chemical fates, and biodiversity, at a lower level of effort.	\$500	\$423	\$225

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BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

Biofuels Energy Systems - Transportation - Feedstock Production (Cont'd) *	FY 1997	FY 1998	FY 1999
<p>Energy Crop Seedling/Planting Stock Selection Research: 1997 and 1998 - Using advanced biotechnology and other methods, identify techniques that can be used to select energy crop seedlings or other planting stocks that are less susceptible to disease and/or pest, reducing the risk of mortality and increasing technical/economic viability.</p> <p>1999 - Continue to develop and apply tissue culture techniques to select and propagate desired genotypes of switchgrass.</p>	\$300	\$100	\$100
<p>Large Scale Woody Crop Plantation Research: 1997 and 1998 - Continue to research and evaluate management techniques to overcome the water use efficiency constraints in the Southeast.</p> <p>1998 and 1999 - Provide technical assistance and cost sharing for large scale plantings in the Midwest/North Central region to obtain performance and cost data.</p>	\$150	\$150	\$125
<p>Switchgrass Variety Testing and Scale-up Research: 1997 - Established new switchgrass variety tests in locations that were identified as having high potential for technical and economic viability of these crops, but where very little data currently existed to develop the best clones or varieties specifically adapted to the variable conditions in the major growing regions of the U.S.</p> <p>1998 - Continue switchgrass variety tests.</p> <p>1999 - Continue variety tests and initiate cost-shared 100-300 acre scale-up plantings of switchgrass in the Midwest or South to obtain yield, operational and costs data.</p>	\$200	\$200	\$900

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

Biofuels Energy Systems - Transportation - Feedstock Production (Cont'd) *	FY 1997	FY 1998	FY 1999
Mechanization Research: 1997 and 1998 - Evaluate mechanization systems for energy crops to lower harvesting/handling cost, a major obstacle to the widespread use of energy crops. 1999 - Develop cost-shared opportunities for switchgrass handling and storage specifically as a means of improving the ethanol production costs.			
	\$50	\$50	\$150
TOTAL Biofuels Energy Systems - Transportation - Feedstock Production *	\$2,500*	\$2,500*	\$6,000

* Feedstock production research in FY 1997 and FY 1998 is co-funded by Biopower-Utilities and Biofuels-Transportation in accordance with Congressional report language. Activities for FY 1997 and FY 1998 support a core program that is designed to meet the needs of both programs. Total Feedstock Production FY 1997 funding: \$2,100,000 + \$2,500,000 = \$4,600,000. Total FY 1998 funding: \$1,723,000 + \$2,500,000 = \$4,223,000. See crosscut schedule at end of section.

Biofuels Energy Systems - Transportation - Regional Biomass Energy Program *	FY 1997	FY 1998	FY 1999
Regional Biomass Resource Activities: 1997, 1998 and 1999 - Continue regionally-focused activities with State and local governments and industry to develop capability to produce and use biomass resources.			
	\$3,325	\$1,650	\$2,000

SOLAR AND RENEWABLE ENERGY

BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

Biofuels Energy Systems - Transportation - Regional Biomass Energy Program (Cont'd) *	FY 1997	FY 1998	FY 1999
Biofuels Production Activities: 1998 and 1999 - Using the regional program infrastructure, provide support for cost-shared site studies for biofuels production facilities, including resource assessments and analyses of local, State, and regional nontechnical issues. 1999 - Improve the potential of biodiesel by developing and testing new biodiesel fuel formulations to enhance fuel performance of high efficiency engines			
	\$0	\$1,335	\$1,500
TOTAL Biofuels Energy Systems - Transportation - Regional Biomass Energy Program	\$1,750*	\$2,000*	\$3,500
TOTAL Biofuels Energy Systems - Transportation	\$27,165	\$30,676	\$46,891

* Regional Biomass Energy Program activities in FY 1997 are co-funded by Biopower-Utilities and Biofuels-Transportation in accordance with Congressional report language. Activities for FY 1997 and FY 1998 support a core program that is designed to meet the needs of both programs. Total FY 1997 Regional Biomass Energy Program funding: \$1,575,000 + \$1,750,000 = \$3,325,000. Total FY 1998 funding: \$985,000 + 2,000,000 = \$2,985,000. See crosscut schedule at end of section.

TOTAL Biopower Energy Systems - Utilities	\$27,162	\$28,164	\$42,900
TOTAL Biofuels Energy Systems - Transportation	\$27,165	\$30,676	\$46,891
TOTAL Biopower/Biofuels Energy Systems	\$54,327	\$58,840	\$89,791

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BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

Crosscutting Schedule:

Feedstock Production and Regional Biomass Energy Program

	FY 1997	FY 1998	FY 1999
Feedstock Production:			
Biopower Energy Systems - Utilities	\$2,100	\$1,723	\$0
Biofuels Energy Systems - Transportation	\$2,500	\$2,500	\$6,000
Total, Feedstock Production	\$4,600	\$4,223	\$6,000
Regional Biomass Energy Program:			
Biopower Energy Systems - Utilities	\$1,575	\$985	\$0
Biofuels Energy Systems - Transportation	\$1,750	\$2,000	\$3,500
Total, Regional Biomass Energy Program	\$3,325	\$2,985	\$3,500

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Thermochemical Conversion (Utilities): The increase of \$1,200,000 allows the program to carry out additional research on fuel cell and Stirling engine integration with gasifiers. It would also allow for research on cofiring ash deposition. \$1,200,000

Systems Development (Utilities): The increase of \$15,908,000 is necessary to meet our commitment for government cost-share for construction of a biomass power plant. \$15,908,000

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BIOPOWER/BIOFUELS ENERGY SYSTEMS (Cont'd)

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999 (Cont'd):

<u>Biomass for Cogeneration (Utilities):</u> The increased amount of \$336,000 is part of a total funding amount of \$2,900,000 that will be used for analyzing the gasification and combustion products of low/medium Btu fuels in highly efficient gas turbines. Previously, funding in this area was applied towards turbine hardening activities.	\$336,000
<u>Feedstock Production (Utilities):</u> Funding has been consolidated in the Biofuels Transportation budget.	\$-1,723,000
<u>Regional Biomass Energy Program (Utilities):</u> Funding has been consolidated in the Biofuels Transportation budget.	\$-985,000
<u>Ethanol Production (Transportation):</u> The increase of \$10,965,000 permits the program to focus on two important production process efficiency and cost factors, cellulase production and pretreatment; to increase the integrated process development activities; and to increase funds for activities related to feasibility studies and cellulose to ethanol facilities. This will provide the ground work for a broad-based commercial technology demonstration strategy.	\$10,965,000
<u>Biodiesel Production (Transportation):</u> The increase of \$250,000 permits the program to continue to pursue cost reduction technology improvements and address other barriers, to increased biodiesel use.	\$250,000
<u>Feedstock Production (Transportation):</u> The increase of \$3,500,000 restores a viable base program to pursue the program's mid- and long-term objectives, while permitting the program to focus on near-term objectives of deploying ethanol production technologies.	\$3,500,000
<u>Regional Biomass Energy Program (Transportation):</u> The increase of \$1,500,000 permits the program to more effectively use the existing infrastructure to deploy biofuels technologies, through cost-shared grants and activities with State Energy Offices and other Federal and regional organizations.	\$1,500,000
Total, Biopower/Biofuels Energy Systems	\$30,951,000

SOLAR AND RENEWABLE ENERGY

WIND ENERGY SYSTEMS

(Tabular dollars in thousands, Narrative in whole dollars)

I. Mission Supporting Goals and Objectives: The mission of the Wind Energy Systems Program is to establish wind energy as a regionally diversified, cost-effective power generation technology, through a coordinated research effort with industry and utilities that will minimize technical and institutional risks for U.S. companies competing in domestic and international markets.

Wind is an attractive energy source for several reasons: 1) wind generated electricity has the potential for serving as an inexpensive energy source for consumers and industries; 2) wind generated electricity produces no polluting emissions or greenhouse gases; and 3) the international market for wind turbines is large and growing rapidly. In 1995, worldwide wind electric generating capacity increased by over 40 percent through the addition of 1400 MW, with sales valued at \$1.5 billion. Aggressive wind energy growth continued in 1996 with the addition of over 1,200 MW capacity worldwide. By 2000, annual sales of wind energy technologies in the world market are estimated to reach \$2-3 billion. While the U.S. wind industry is beginning to establish a foothold in this market, European and Japanese manufacturers continue to aggressively develop advanced technology and are increasingly competitive.

The Wind Energy Systems program conducts its research and development efforts to help U.S. industry develop wind technology as an economically viable energy supply option and to gain a technological edge over international competition. In FY 1999, the program will focus on Applied Research, Turbine Research, and Cooperative Research and Testing. The Applied Research program addresses fundamental engineering and technology issues associated with a broad range of applications and is carried out at national laboratories and numerous universities. The Turbine Research program is a coordinated effort with industry and utilities which performs cost shared research to develop the next generation of wind turbines. The Cooperative Research and Testing program conducts R&D and prototype testing at the world class National Wind Technology Center in Colorado which features a new user facility that allows U.S. companies to expand testing of new wind energy technologies. These program elements complement the activities of the National Wind Coordinating Committee, a public/private partnership of producers, utilities, regulators, environmentalists and trade organizations that helps shape the Wind Energy Systems Program.

The Wind Energy Systems program has been extraordinarily successful in bringing down the cost of wind-generated electricity from 35 cents per KWh in 1980, to 7 cents per KWh in 1989, and 4 cents per KWh (in 15 mph winds) today. At current costs and in selected

SOLAR AND RENEWABLE ENERGY

WIND ENERGY SYSTEMS (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

markets, wind energy can be competitive with conventional energy sources on a life-cycle basis. Ultimately, wind energy will compete with gas- and coal-fired plants, which dominate the generation mix in the Midwestern U.S. where the majority of the country's good wind resource is located. To allow use of this large resource base, and to allow wind energy to be competitive in an era of utility restructuring that emphasizes low initial cost and independent power projects, significant improvements to the technology are still needed to reach the Program's goal of 2.5 cents per kWh in 15 mph winds by 2002.

As wind technology moves closer to full commercialization, the Wind Energy Systems Program intends to increase the private sector's share of R&D and demonstration project costs. For example, Federal support for Turbine Research is expected to decrease after FY 2000 as wind technology becomes increasingly competitive with traditional power sources and as utilities and industry contribute an increasing percentage of funding for activities at the National Wind Technology Center (NWTTC).

A. Estimates of Benefits (These are cumulative benefits assuming a zero baseline in 1998.)

	2000	2010	2020
Annual Primary Energy Displaced (Quads)	.03	.31	1.62
Carbon Equivalent Emissions Reductions (MMT)	.65	6.7	35

Wind energy generating capacity installed in the U.S. currently totals over 1700 MW, is expected to grow to 2200 MW by 2000, and reach 9,600 MW by 2010. Wind energy emissions reduction impacts are enhanced by regional effects because much of the anticipated expansion in wind energy use will occur in the Midwest, where coal dominates the current generation mix.

B. Goals

The following performance measures have been and will be used by the Wind Energy Systems Program to track its commitment to meeting its year 2002 goal of producing electricity from wind energy for 2.5 cents per kWh in 15 mph winds with favorable financing.

1997 Performance Measures

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WIND ENERGY SYSTEMS (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

- Contracts for new advanced technology wind turbine development projects have been signed with six U.S. companies that will result in performance improvement of over 20% compared to current technology.
- Five additional U.S. utilities were selected from a competitive solicitation to undertake new wind energy test and evaluation projects.

1998 Performance Measures

- Over 30 MW of cost-shared wind energy projects installed.
- First village power pilot project for domestic and international applications installed.

1999 Performance Measures

- Two new cost-shared projects initiated for field verification of advanced wind turbine technologies.
- 12% of world wind energy market secured by U.S. industry.

2000 - 2005 Performance Measures

- Advanced wind turbines deployed that are capable of producing electricity at 2.5 cents per kWh in 15 mph winds.
- 2700 MW of domestic installed capacity achieved.
- 25% of world wind energy market secured by U.S. industry.

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WIND ENERGY SYSTEMS (Cont'd)

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
Applied Research	\$ 12,200	\$ 11,500	\$ 10,700	\$ -800	-7%
Turbine Research	8,500	13,000	24,800	11,800	48%
Cooperative Research and Testing	<u>7,946</u>	<u>8,027</u>	<u>8,000</u>	<u>-27</u>	<u>0%</u>
Total, Wind Energy Systems	<u>\$ 28,646</u>	<u>\$ 32,527</u>	<u>\$ 43,500</u>	<u>\$ 10,973</u>	<u>25%</u>

III. Performance Summary - Accomplishments:

Applied Research	FY 1997	FY 1998	FY 1999
Core Research: 1997 - Continued to improve technology base for wind industry through research at the National Laboratories, and complete installation of the new Advanced Research Turbine Test Facility at the NWTC. 1998 - Continue to improve technology base for wind industry through research at the National Laboratories, and complete 1.5 megawatt dynamometer facility construction and installation. 1999 - Continue to improve technology base for wind industry through research at the National Laboratories, and complete wind tunnel testing of the unsteady aerodynamics turbine in cooperation with NASA.	\$9,340	\$9,200	\$8,400

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WIND ENERGY SYSTEMS (Cont'd)

Applied Research (Cont'd)	FY 1997	FY 1998	FY 1999
University Research: 1997 - Continued research with twelve universities, and award two new Historically Black Colleges and Universities (HBCU) contracts. 1998 - Continue research with twelve universities, and award new HBCU, Hispanic Educational Institutions (HEI), and other university contracts. 1999 - Continue research with ongoing university contracts.			
	\$1,200	\$1,000	\$1,000
Wind Hybrid Systems: 1997 - Completed design and testing of control system for wind/hybrid system (e.g., wind/PV) for a high penetration village power application. 1998 - Complete research testing program of a new wind/hybrid power system, with an industrial partner, using the NWTC wind/hybrid test facility. 1999 - Complete first year tests of high penetration village power project.			
	\$1,090	\$1,000	\$1,000
Avian Research: 1997 - Completed golden eagle population study and related avian modeling. 1998 - Complete avian risk reduction studies. 1999 - Complete first avian study of a wind facility before and after development, including an undeveloped control area.			
	\$570	\$300	\$300
TOTAL Applied Research	\$12,200	\$11,500	\$10,700

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WIND ENERGY SYSTEMS (Cont'd)

Turbine Research	FY 1997	FY 1998	FY 1999
<p>Near-Term Research and Testing: 1997 - Using prior year funding, selected three companies for cost shared contracts under Near Term Research and Testing (NTRT) project.</p> <p>1998 - Complete final designs for Near Term Research and Testing project turbines and begin prototype fabrication.</p> <p>1999 - Complete field testing of Near Term Research and Testing project prototypes.</p>	\$0	\$2,000	\$2,900
<p>Next Generation Turbine Project: 1997 - Using prior year funding, completed design and initiated fabrication of proof-of-concept turbines under the continuing next-generation turbine development project.</p> <p>1998 - Complete proof-of-concept testing and begin fabrication of full scale next generation wind turbine prototypes. (Industry cost-share contribution is \$2,000.)</p> <p>1999 - Complete fabrication of one engineering and manufacturing development prototype next generation turbine, and begin field testing. (Industry cost-share contribution is \$3,000)</p>	\$0	\$5,000	\$8,000
<p>Small Wind Turbine Project: 1997 - Using prior year funding, awarded four contracts and begin work under the small wind turbine project.</p>			

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WIND ENERGY SYSTEMS (Cont'd)

Turbine Research (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Small Wind Turbine Project (Cont'd): 1998 - Complete fabrication of proof-of-concept wind turbines under the small wind turbine project, and begin field testing.</p> <p>1999 - Complete fabrication and begin field testing of small wind turbine project prototypes.</p>	\$0	\$500	\$1,000
<p>Supporting Research, Testing, and Management: 1997 - Provided testing, design review, analysis, and management support for 18 industry subcontract projects.</p> <p>1998 - Provide testing, design review, analysis, and management support for 11 industry subcontract projects (performance periods range from 2½ to 5 years).</p> <p>1999 - Provide testing, design review, analysis, and management for 11 industry subcontract projects. Complete construction of distributed wind generation projects initiated in FY97 (using prior year funds) under the Turbine Verification Program (TVP). Select two to three partners under a new Turbine Verification Program solicitation for projects up to 25 MW in size that are tailored to the requirements of the restructured electric power market of the state or region the project serves. The projects would be based on the TVP model, and selected through a competitive solicitation with a targeted 90% industry cost share.</p>	\$8,500	\$5,500	\$12,900
TOTAL Turbine Research	\$8,500	\$13,000	\$24,800

SOLAR AND RENEWABLE ENERGY

WIND ENERGY SYSTEMS (Cont'd)

Cooperative Research and Testing	FY 1997	FY 1998	FY 1999
<p>Industry Support: 1997 - Assisted U.S. industry using the facilities at the NWTC, and in accordance with Congressional direction, provide support for the Kotzebue, Alaska wind farm development project.</p> <p>1998 - Assist U.S. industry using the facilities at the NWTC, and complete resource assessment and prefeasibility study for wind/hybrid mini-grid project in a developing country.</p> <p>1999 - Assist U.S. industry and other Federal agencies (USDA, DOD) in development of both grid-connected wind farms and off-grid wind hybrid projects for both domestic and international applications.</p>	\$3,600	\$3,600	\$4,000
<p>Certification and Standards: 1997 - Completed wind turbine structural loads, electrical, and component certification testing procedures to conform to existing international standards.</p> <p>1998 - Complete requirements for International Standards Organization accreditation for wind turbine certification testing at the National Wind Technology Center.</p> <p>1999 - Establish a United States-based commercial firm as an internationally accredited certification agent for wind turbine systems.</p>	\$1,500	\$2,000	\$1,700

SOLAR AND RENEWABLE ENERGY

WIND ENERGY SYSTEMS (Cont'd)

Cooperative Research and Testing (Cont'd)	FY 1997	FY 1998	FY 1999
Utility Analysis: 1997 - Completed acquisition of wind resource data collected by Utility Wind Interest Group participants and initiated wind utility value analysis project with competitively selected stakeholders. 1998 - Complete wind utility value analysis project, allowing promotion of specific high value domestic electric market segment opportunities for wind energy. 1999 - Complete analysis of grid interaction effects and ancillary service impacts from three utility wind projects.	\$1,400	\$1,127	\$1,000
National Wind Technology Center Operations: 1997 - Provided support for advanced research projects and testing, and completed site road and electrical system upgrades needed for additional research turbines. 1998 - Provide support for advanced research projects and testing. 1999 - Provide support for advanced research projects and testing and construct two additional large turbine test sites.	\$1,446	\$1,300	\$1,300
TOTAL Cooperative Research and Testing	\$7,946	\$8,027	\$8,000
TOTAL Wind Energy R&D	\$28,646	\$32,527	\$43,500

FUNDING CHANGES FROM FY 1998 TO FY 1999:

Applied Research: The decrease of \$800,000 results from reduced efforts in core research. Core research reduction reflects completion of the 1.5 MW Dynamometer facility in FY 1998.

\$-800,000

SOLAR AND RENEWABLE ENERGY

WIND ENERGY SYSTEMS (Cont'd)

Turbine Research: The increase of \$11,800,000 is required to fulfill projected contractual obligations for funding ongoing Turbine Research subcontracts and Turbine Verification Program Projects, and to begin new Turbine Verification Program projects.

\$11,800,000

Cooperative Research and Testing: Minor change.

\$-27,000

Total, Wind Energy Systems

\$10,973,000

SOLAR AND RENEWABLE ENERGY

RENEWABLE ENERGY PRODUCTION INCENTIVE PROGRAM

(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives: The Renewable Energy Production Incentive (REPI) program is part of an integrated strategy contained in the Energy Policy Act of 1992 to promote increases in the generation and utilization of electricity from renewable energy sources and to further the advancement of renewable energy technologies. Under this program, annual appropriations provide financial incentives to new (operations started October 1, 1993 or later) qualified renewable energy facilities owned by State entities, municipal utilities, and electric cooperatives for the production of electricity. For these tax-exempt owners of new renewable energy generation units, REPI will provide financial incentives that are comparable to the value of the production tax credits for investor-owned renewable energy generators and the investment tax credits for non-utility investors in certain renewable energy generation technologies.

A. Estimate of Benefits

With FY 1997 appropriations and prior year balances, the REPI program has provided incentive payments for production from 18 new renewable energy facilities, which generated about 177 million kilowatt-hours of electricity in Fiscal Year 1996. Available appropriations allowed full payments for solar and wind energy facilities and partial payments (86.9 percent of full payments) for open-loop biomass facilities. (Final Fiscal Year 1997 figures are not yet available.)

B. Goals

FY 1997 Performance Measures

- FY 1997 appropriations provided incentive payments for production from new renewable energy facilities, which generated 177 million kilowatt-hours in fiscal year 1996.

FY 1998 Performance Measures

- FY 1998 appropriations will provide incentive payments for production from new renewable energy facilities, which are projected to have generated about 500 million kWh in fiscal year 1997. These appropriations will allow full payments for solar and wind energy facilities and partial payments for open-loop biomass facilities.

SOLAR AND RENEWABLE RESOURCE TECHNOLOGIES

RENEWABLE ENERGY PRODUCTION INCENTIVE PROGRAM (Cont'd)

FY 1999 Performance Measures

- Requested FY 1999 appropriations will provide incentive payments for production from new renewable energy facilities, which are projected to generate about 680 million kWh in fiscal year 1998. These appropriations will allow full payments for solar and wind energy facilities and partial payments for open-loop biomass facilities.

FY 2000-2005 Performance Measures

- The program is expected to produce steady increases in renewable energy output, exceeding a billion kWh annually during this period.

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
REPI	<u>\$ 2,000</u>	<u>\$ 2,954</u>	<u>\$ 4,000</u>	<u>\$ 1,046</u>	<u>35%</u>
Total, Renewable Energy Production					
Program	<u>\$ 2,000</u>	<u>\$ 2,954</u>	<u>\$ 4,000</u>	<u>\$ 1,046</u>	<u>35%</u>

SOLAR AND RENEWABLE ENERGY

RENEWABLE ENERGY PRODUCTION INCENTIVE PROGRAM (Cont'd)

III. Performance Summary - Accomplishments:

Renewable Energy Production Incentive Program	FY 1997	FY 1998	FY 1999
1997 - Provided electricity production incentive payments to qualified participants; published rule clarification; solicited public input on options to increase the effectiveness of the REPI program.			
1998 - Provide electricity production incentive payments to qualified participants.			
1999 - Provide electricity production incentive payments to qualified participants.	\$2,000	\$2,954	\$4,000
TOTAL Renewable Energy Production Incentive Program	\$2,000	\$2,954	\$4,000

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Renewable Energy Production Incentive Program:

To cover increased production by qualifying facilities.

\$1,046,000

Total Funding Change, Renewable Energy Production Incentive Program

\$1,046,000

SOLAR AND RENEWABLE ENERGY

SOLAR PROGRAM SUPPORT

(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives: Solar Program Support includes two programs: Analysis of Restructuring of the U.S. utility sector and a 5-year Open Solicitation for early deployment renewable energy technologies.

ELECTRIC INDUSTRY RESTRUCTURING: The Electric Industry Restructuring program involves research on and outreach activities related to the restructuring of U.S. electric utility markets and the potential impacts, both positive and negative, on the development and deployment of renewable and energy efficiency technologies and programs. The purpose is to provide analysis and technical assistance, in collaboration with other departmental elements, to Federal, State and local policymakers that will help them to address renewable, energy efficiency and other public purpose goals through market-based, regulatory, and legislative mechanisms as they seek to obtain the economic benefits associated with introducing competition into the electricity industry. It includes activities on retail choice plans, green marketing strategies, integrated energy services, new technologies and services, renewable portfolio standards, information disclosure provisions, consumer education, net metering, and market transformation programs. The activities are geared toward developing and disseminating technical analysis and consumer information on these types of policies and mechanisms. Outreach activities are critical in communicating the results to interested parties across the country. The primary focus is to ensure that key restructuring decision makers have access to the best available technical information for developing policies that sustain renewable and energy efficiency technologies in increasingly competitive electricity markets.

A. Estimates of Benefits

This effort is to start in FY 1999. Expected benefits in 1999 include having more states use mechanisms to sustain renewable and energy-efficiency technologies in their utility restructuring legislation or regulations. In addition, the Administration's electricity legislation proposals will have a stronger analytical basis, thus increasing the likelihood that renewable and energy efficiency policies are addressed appropriately. During deliberations and possible enactment of proposed Federal and state legislation, coordination with states about public purpose programs will be more effective because of the technical analyses and outreach provided by this funding.

SOLAR AND RENEWABLE ENERGY

SOLAR PROGRAM SUPPORT (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

B. Goals

FY 1997 Performance Measures

- None

FY 1998 Performance Measures

- None

FY 1999 Performance Measures

- Requested FY 1999 appropriations will provide support for technical analysis and outreach activities on renewable energy portfolio standards, public benefits funds, information disclosure provisions and other mechanisms to encourage federal and state policy makers to enact provisions to sustain renewable and energy-efficiency technologies and programs in restructured utility markets. Performance will be measured by the numbers of analyses performed, and the degree to which information is effectively disseminated.

FY 2000-2005 Performance Measures

- By disseminating information, providing outreach and technical analyses, and providing forums for discussion among key decision makers, the program is expected to increase the number of states that enact provisions for supporting renewable-energy development and energy-efficiency technologies. The program is expected to encourage a smooth transition for renewable and energy-efficiency technologies and programs to increasingly competitive utility markets. The program is expected to encourage

SOLAR AND RENEWABLE ENERGY

SOLAR PROGRAM SUPPORT (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

greater coordination between the federal government, state agencies, and regional entities in the development and implementation of utility restructuring regulations and legislation.

5-YEAR OPEN COMPETITIVE SOLICITATION FOR RENEWABLE ENERGY TECHNOLOGIES:

I. Mission Supporting Goals and Objectives: To establish a 5-year Open Competitive Solicitation for renewable energy technologies to accelerate widespread domestic acceptance and marketplace penetration and reduce carbon emissions. Implementation of renewable energy projects is hampered by the uncertainties of electric utility restructuring, current low price and perceived availability of natural gas, and improvements in gas turbine technology. While renewables can be competitive on a life-cycle basis in selective niche markets today, the competitive restructured environment favors low first cost alternatives. Yet, renewables can play a major role in mitigation of green house gas emissions in the period from 2008 and thereafter, and are an essential component of a transition to a sustainable future. The lack of familiarity with renewables and the new emerging market structures (power marketers, hybridized projects investments in customer-sided renewables and distributed generation, and other forms of green energy and customer choice) are major uncertainties currently inhibiting additional domestic deployment.

The Department would issue a technology-neutral competitive solicitation to seek out the best projects across the portfolio of renewable energy technologies, or combinations thereof. Key criteria would include: carbon and other pollution reduction; verification and validation of technologies for various applications; replicability; potential for success; accelerating the development of domestic industry and markets to achieve “critical mass” self sustaining manufacturing levels; export potential; and the ability to leverage significant amounts of non-Federal funds.

A. Estimates of Benefits

It is estimated that Federal funds of \$10 million per year would directly leverage further investments of up to \$30 million per year (depending on technology mix), corresponding to the annual installation of more than 100Mw (0.2 million metric tons of reduced

SOLAR AND RENEWABLE ENERGY

SOLAR PROGRAM SUPPORT (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

carbon emissions) 115 MW (0.21 million metric tons of direct carbon equivalent displaced) directly per year of new renewable energy projects tailored for the new, competitive electric marketplace. Because the program would target projects that are readily expanded, benefits are projected 3 to 5 years after the initial projects become operational due to additional private investments stimulated by the leveraged projects.

B. Goals

FY 1997 Performance Measures

- No activities.

FY 1998 Performance Measures

- Discussions with DOE's Regional Support Offices, the Golden Field Office, and appropriate OUT program offices on development of the competitive solicitation documents and FY 1999 performance measures will be initiated; a competitive solicitation will be issued in late FY98.

FY 1999 Performance Measures

- FY 1999 appropriations will give the flexibility to award these funds according to the merits of the proposals, with no particular minimum amount guaranteed to any particular technology. \$3M of the \$10M appropriated will be competitively selected to fund projects benefitting Native Americans. Awards to be made mid-FY99.

FY 2000-2005 Performance Measures

\$10 million to be awarded each year, with the amount dedicated towards benefitting Native Americans to be decided each year.

SOLAR AND RENEWABLE ENERGY

SOLAR PROGRAM SUPPORT (Cont'd)

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
Electric Restructuring	\$ 0	\$ 0	\$ 4,000	\$ 4,000	100%
5-Year Open Competitive Solicitation	<u>\$ 0</u>	<u>\$ 0</u>	<u>\$ 10,000</u>	<u>\$ 10,000</u>	<u>100%</u>
Total, Solar Program Support	<u>\$ 0</u>	<u>\$ 0</u>	<u>\$ 14,000</u>	<u>\$ 14,000</u>	<u>100%</u>

III. Performance Summary - Accomplishments:

Solar Program Support	FY 1997	FY 1998	FY 1999
Electric Restructuring: 1997 - No activities. 1998 - No activities. 1999 - Provide support for technical analysis and outreach activities on renewable energy portfolio standards, public benefits funds, information disclosure provisions and other mechanisms to encourage federal and state policy makers to enact provisions to sustain renewable and energy-efficiency technologies and programs in restructured utility markets.	\$0	\$0	\$4,000

SOLAR AND RENEWABLE ENERGY

SOLAR PROGRAM SUPPORT (Cont'd)

Solar Program Support (Cont'd)	FY 1997	FY 1998	FY 1999
5-Year Open Competitive Solicitation: 1997 - No activities. 1998 -Initiate discussions between Regional Support Offices, Golden Field Office, and appropriate OUT program offices on development of the competitive solicitation documents. Prepare competitive solicitation to be issued in late FY98. 1999 -Review of proposals and selections for negotiations of awards. Awards to be made mid-FY99.			
	\$0	\$0	\$10,000
TOTAL Solar Program Support	\$0	\$0	\$14,000

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Electric Restructuring: Strengthening activities to understand implications of utility restructuring on renewable and energy-efficiency technologies and to coordinate with federal and state utility restructuring policy makers to develop public policy and market-based strategies to sustain renewable and energy-efficiency technologies in restructured utility markets. \$4,000,000

5-Year Open Competitive Solicitation:

New program activity to accelerate acceptance and deployment of renewable energy technologies. \$10,000,000

Total Funding Change, Solar Program Support **\$14,000,000**

SOLAR AND RENEWABLE ENERGY

INTERNATIONAL SOLAR ENERGY PROGRAM

(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives: The International Solar Energy Program strives to increase the capacity of other countries to use proven renewable energy technologies. By addressing market barriers, the programs “pull” rather than “push” the technologies into the marketplace, thereby bringing economic growth, U.S. jobs, a cleaner environment, and a lower future price for the technologies. The International Solar Energy Program, working cooperatively with the private sector, achieves its mission by developing an understanding, acceptance and indigenous capacity to use renewable energy technologies.

The International Solar Energy Program was established in response to legislative mandates to help ensure rapid and efficient deployment of renewable energy technologies in order to stimulate near-term economic growth and lay the groundwork for long-term growth. It addresses specific problems that slow the acceptance of new and existing technologies and speeds the deployment of technologies by targeting clearly defined markets or distinct market barriers. It supports efforts to increase the competitiveness of the U.S. renewable energy industry in large and rapidly growing global energy markets.

The International Solar Energy Program comprises three elements. The Committee on Renewable Energy Commerce and Trade (CORECT) is an interagency group that collaborates with the renewable energy industry to coordinate Federal export activities, support cost-shared trade and economic development projects, and counter intense international competition. The Americas 21st Century Program (A21), developed in accordance with CORECT’s strategic plan, assisted Latin American and Caribbean (LACC) countries in the field validation and deployment of renewable energy technologies through cost-shared joint ventures with the LAC public and private sectors. In FY 1999, A21 will duplicate these activities in the Asia/Pacific Region and in additional areas of Russia. The U.S. Initiative on Joint Implementation (USII) promotes public/private cooperation projects that reduce or sequester greenhouse gas emissions. It, and the related Initiative for Clean Development (ICD), support the Administration’s objective of engaging the developing countries and countries in transition in a dialogue to encourage them to accept their responsibility for mitigating greenhouse gas emissions. The ICD and USII will work closely with the voluntary International Energy Agency (IEA)/Organization for Economic Cooperation and Development (OECD) Climate Technology Initiative (CTI) which is now chaired by the U.S. to foster and strengthen national and international development and deployment of climate-friendly technologies by: promoting awareness and of existing technological responses to climate change concerns; sharing expertise and experience between countries; identifying gaps in national and multilateral technology programs to strengthen climate response strategies; and strengthening practical international collaboration activities to make technology responses to climate change concerns more effective.

SOLAR AND RENEWABLE RESOURCE TECHNOLOGIES

INTERNATIONAL SOLAR ENERGY PROGRAM (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd.):

A. Estimates of Benefits

The International Solar Energy Program will yield benefits in terms of the environment and energy savings in the countries purchasing the technologies, while increasing U.S. exports, jobs, and Federal tax revenues. By 2000, the Solar International program will stimulate \$10-20 in exports for every dollar spent.

B. Performance Measures (highlights)

The following performance measures will be used by the International Solar Energy Program to monitor its progress toward meeting its commitments and goals:

1997 Performance Measures

- Continued implementation of the Initiative For Clean Development as the Clean Development Mechanism, and the U.S. Initiative on Joint Implementation program.

1998 Performance Measures

- Increase activities to remove barriers to U.S. companies in energy efficiency and renewable markets in the Newly Independent States, China, Indonesia, the Philippines, Brazil, India, and South Africa.
- Continue implementation of the Initiative For Clean Development as the Clean Development Mechanism, and the U.S. Initiative on Joint Implementation program.
- Coordinate export assistance among Federal agencies for renewable energy technologies, stimulate market development, and avoid wasteful duplication.
- Support voluntary public/private partnerships that use U.S. renewable energy technologies to reduce greenhouse gas emissions.

SOLAR AND RENEWABLE RESOURCE TECHNOLOGIES

INTERNATIONAL SOLAR ENERGY PROGRAM (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd.):

- Identify project opportunities for U.S. renewable energy and energy efficiency technologies and address the non-technical barriers to their use in foreign markets.

1999 Performance Measures

- Undertake non-technical activities to reduce non-technical barriers, including lack of financing resources, and prohibitions, tariffs for U.S. renewable energy and energy efficiency firms seeking business in the Newly Independent States, China, Indonesia, the Philippines, Brazil, India, and South Africa.
- Increase market preparation, field validation and deployment activities in Asian and Pacific markets (including China, Indonesia and the Philippines), Russia and continue to build on work in Africa and Latin America.
- Increase number of projects receiving assistance that reduce greenhouse gas emissions through the Clean Technology Initiative.
- Identify gaps in national technology programs and strengthen climate response strategies by sharing expertise among countries.
- Increase activities to promote the adoption and use of U.S. renewable energy and energy efficiency technologies in regional reconstruction.

2000 - 2005 Performance Measures

SOLAR AND RENEWABLE RESOURCE TECHNOLOGIES

INTERNATIONAL SOLAR ENERGY PROGRAM (Cont'd)

- Generate significant exports of renewable energy technologies and Federal tax revenues through information dissemination, technical assistance, participation in international organizations and activities aimed at identifying opportunities for renewable energy technologies in other countries.
- Increase the number of countries engaged in developing their own plans for economic growth, greenhouse gas mitigation, and environmental protection. Increase the number of countries actively involved in supporting private sector development of greenhouse gas mitigation projects.

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
International Solar Energy Program	\$ 661	\$ 1,375	\$ 8,800	\$ 7,425	540%
Total, International Solar Energy Program . .	\$ 661	\$ 1,375	\$ 8,800	\$ 7,425	540%

SOLAR AND RENEWABLE RESOURCE TECHNOLOGIES

INTERNATIONAL SOLAR ENERGY PROGRAM (Cont'd)

III. Performance Summary - Accomplishments:

International Solar Energy Program	FY 1997	FY 1998	FY 1999
CORECT: 1997 - Continued activity based on available prior year funds. 1998 - Continue to coordinate Federal export assistance to the U.S. renewable energy industry. 1999 - Initiate efforts to deploy U.S. manufactured renewable energy technologies worldwide.	\$0	\$0	\$2,000
Americas' 21st Century: 1997 - No activity. 1998 - Expand into Asia (China, Indonesia and the Philippines) in addition to Latin America. 1999 - Expand market preparation, field validation and deployment activities into Asia/Pacific (e.g., China, Indonesia and the Philippines), and Russia in addition to Latin America.	\$0	\$0	\$3,400
USIJI (Climate Change Technology Initiative): 1997 - Continued a number of cost-effective projects implemented jointly between U.S. industry and partners in developing countries and countries with economies in transition, and provided technical assistance to U.S. firms and their partners.			

SOLAR AND RENEWABLE RESOURCE TECHNOLOGIES

INTERNATIONAL SOLAR ENERGY PROGRAM (Cont'd)

International Solar Energy Program (Cont'd)	FY 1997	FY 1998	FY 1999
USIJI (Climate Change Technology Initiative) (Cont'd): 1998 - Assist in the development of public/private partnerships in an implementation of voluntary, cost-effective projects between U.S. and non-U.S. partners in a greater number of countries. 1999 - Expand projects to reach greater geographical and technological diversity and increase marketing and outreach activities. Expand support for National Action Plans and sharing of needed technological expertise. Expand the number of developing countries and countries in transition in accepting their responsibility to participate in greenhouse gas emission reduction efforts by supporting private sector development of these projects.	\$661	\$1,375	\$3,400
TOTAL International Solar Energy Program	\$661	\$1,375	\$8,800

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

International Solar Energy Program: The additional funding in FY 1999 will restore funding to the CORECT and America's 21st Century programs and expand activities under the U.S. Initiative on Joint Implementation. \$7,425,000

Total Funding Change, International Solar Energy Program \$7,425,000

SOLAR AND RENEWABLE ENERGY

SOLAR TECHNOLOGY TRANSFER

(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives: The Technical Information and Communications Programs (formerly the Solar Technology Transfer program) provide free information on energy efficient and renewable energy (EERE) technologies to a wide range of audiences. These programs are the government's tools to provide citizen access to the technologies and advancements achieved through our research and development efforts. This is a return on investment that gets the research results off the shelf and into the "real world."

The Technical Information and Communications Programs help all citizens -- homeowners, small and medium-sized businesses, consumers, students and educators, state and local governments, industry and utilities. These programs provide information and products through the Energy Efficiency and Renewable Energy Clearinghouse (EREC), which distributes information products about EERE technologies. EREC fills a need to which the private sector cannot meet by providing taxpayers with free, unbiased technical information and assistance about EERE technologies.

In addition, these programs respond to citizens in their time of need by distributing free disaster-relief publications to stricken areas of the United States. For example, these services have provided information to communities hit by floods, which helps the residents to rebuild their homes and businesses using more efficient and sustainable technologies, which will serve them better for years to come.

A. Estimates of Benefits

EREC provides the link from research and development partners to U.S. citizens, and enables them to incorporate technologies and advances into their homes and businesses, thereby enhancing our country's energy efficiency and increasing the application of renewable technologies. These services capitalize on the research investment in the labs and elsewhere and lead to "real-world" applications of the advances made in EERE technologies.

B. Performance Measures (highlights)

SOLAR AND RENEWABLE ENERGY

SOLAR TECHNOLOGY TRANSFER (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

The following performance measure will be used by the Technical Information and Communications Programs to monitor their progress toward meeting their commitments and goals:

1997 Performance Measures

- Using prior year funds, EREC will respond to at least 60,000 phone, mail, fax, computer bulletin board, and Internet requests and complete five new EREC publications.
- Survey EREC customers to gauge user satisfaction and obtain feedback for making improvements to information, service quality, and timeliness.

1998 Performance Measures

- EREC will respond to at least 95,000 phone, mail, fax, computer bulletin board, and Internet requests and complete an average of one new EREC publication per month, based on anticipated funding.
- EREC will survey customers to gauge user satisfaction and obtain feedback for making improvements to information, service quality, and timeliness.
- The Technical Information and Communications program will continue to seed out and research audiences not served by EERE programs for targets distribution of EERE technical information products, serving approximately 150,000 customers.

SOLAR AND RENEWABLE ENERGY

SOLAR TECHNOLOGY TRANSFER (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

1999 Performance Measures

- EREC will maintain a high level of quality service and user satisfaction by obtaining user feedback and will increase requests/accesses to each by continuing our system improvement and outreach efforts.
- EREC will respond to a minimum of 100,000 customer inquiries by phone, fax, mail, Internet, e-mail, and bulletin board service. As more of EREC's users gain availability to electronic resources, the proportion of information requests via Internet and e-mail will increase, thus streamlining response times and procedures.
- Technology Information Program will continue to increase awareness of EERE technology readiness and successes by developing and distributing information products that address customers needs.
- EREC will continue to produce relevant, quality publications on a variety of energy efficiency topics which are very popular with its audience of consumers, homeowners, small business owners, and state energy offices.
- EREC will continue to survey customers to gauge their satisfaction with the service and gain their input as to how the service can even better suit their needs by making further improvements to information, service quality, and timeliness.
- EREC will implement measures to ensure that its high-level customers, such as state energy offices, state and local governments, and utilities, receive the support and service they need.

2000-2005 Performance Measures

- EREC will stay on track to maintain the same high level of service, quality publications, and 95+% customer satisfaction rating that EREC is known for. This will include ongoing surveys of customer satisfaction, implementing further quality measures and follow-up procedures, and thinking forward as to how to best meet its customers' needs.

SOLAR AND RENEWABLE ENERGY

SOLAR TECHNOLOGY TRANSFER (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

- EREC will respond to an estimated 105,000 inquiries from its customers. As more and more users gain access to the Internet and other electronic methods of communication, EREC likely will see a greater proportion of its requests coming in via electronic means.

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
Information and Communications	\$ 0	\$ 0	\$ 1,360	\$ 1,360	100%
Total, Solar Technology Transfer	<u>\$ 0</u>	<u>\$ 0</u>	<u>\$ 1,360</u>	<u>\$ 1,360</u>	<u>100%</u>

SOLAR AND RENEWABLE ENERGY

SOLAR TECHNOLOGY TRANSFER (Cont'd)

III. Performance Summary - Accomplishments:

Information and Communications	FY 1997	FY 1998	FY 1999
<p>1997 - Using prior year funds, EREC responded to approximately 60,000 telephone, mail, fax, computer bulletin board, and Internet e-mail requests due to streamlining of operations; completed new EREC fact sheets; and surveyed users to gauge satisfaction and obtain ideas for improving the service, while maintaining a 95+ percent satisfaction rating.</p> <p>1998 - Using prior year funds, EREC will respond to 95,000 telephone, mail, fax, computer bulletin board, and Internet e-mail requests for information, based on anticipated level of funding; will complete one new EREC fact sheet per month; and will maintain a 95+ percent satisfaction rating. The Technical Information and Communication Program will continue to increase awareness of EERE technology readiness and successes by developing and distributing information products that address specific audience needs.</p> <p>1999 - The FY 1999 request will permit EREC to respond to telephone, mail, fax, computer bulletin board, and Internet e-mail requests. The Technical Information and Communications Program will continue on-going activities from prior years and increase its efforts to provide a one-stop shop for businesses, consumers, and industry. For FY 1999, this program will offer a larger number of renewable energy programs which will provide more efficient distribution of timely and accurate information than is possible with individual inquiries to specific programs or laboratories. These services will result in more effective use of appropriated funds and will reduce the overall cost of responding to the large number of customer inquiries. This will allow for more effective responses to inquiries that cut across standard technology boundaries—again saving staff time and resources.</p>			
TOTAL Information and Communications	\$0	\$0	\$1,360
TOTAL Solar Technology Transfer	\$0	\$0	\$1,360

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Information and Communications:

Total Funding Change, Solar Technology Transfer

\$1,360,000

\$1,360,000

SOLAR AND RENEWABLE ENERGY

SOLAR TECHNOLOGY TRANSFER (Cont'd)

SOLAR AND RENEWABLE ENERGY

GEOHERMAL

I. Mission Supporting Goals and Objectives: The mission of the Office of Geothermal Technologies is to create economic, environmentally attractive geothermal options for U.S. and world energy markets in partnership with U.S. industry and electric utilities and other service providers. The Office also formulates and executes national energy policies and programs relating to geothermal technologies. The joint efforts of public-private geothermal partnerships will improve the environment, furnish attractively priced geothermal energy to foreign and domestic markets, improve the U.S. balance of trade, boost tax revenues, and stimulate domestic employment. The strategy for achieving these ends is for the parties to jointly sponsor research and development leading to advanced technologies that will improve the reliability, further reduce the environmental impact, and lower the cost of geothermal energy systems.

The Geothermal Energy Program will achieve, by 2000, a life-cycle cost of producing electricity of 3.5 cents per kWh from typical geothermal resources (apart from the Geysers, the current cost ranges between 5 and 8 cents per kilowatt-hour). This will result in about 15,000 MW of new capacity installed worldwide by U.S. firms during the ensuing decade. The Department and the U.S. geothermal industry will collaborate to accomplish this by developing cost-competitive geothermal technologies to: 1) locate and confirm new geothermal sites, 2) reduce exploration and drilling costs in hard rock environments, 3) develop advanced techniques for managing geothermal energy production, 4) enhance the efficiency and reliability of converting geothermal heat into electricity, and 5) reduce operating and maintenance costs at existing and planned geothermal facilities. The program also will accelerate adoption of geothermal heat pumps (GHP) with the goal of 750,000 units installed by the year 2000, to reduce the Nation's appetite for electric power, thereby also cutting greenhouse gas emissions. Nearly half of the Geothermal Energy Program is cost-shared on a 50/50 basis with industry and other participants. Moreover, Federal and state governments currently receive in excess of \$20 million each year in geothermal lease and royalty payments.

By increasing the amount of geothermal energy that can be economically recovered, these program actions will help the U.S. geothermal industry to retain U.S. market share over the next decade while capturing over 50 percent of new geothermal international power markets, valued in excess of \$20 billion.

SOLAR AND RENEWABLE ENERGY

GEOHERMAL (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

Geothermal energy in its various forms comprises more than 40% of the U.S. energy resource base. Electric power from geothermal resources is generated with low environmental impact and is the most reliable of all base-load power energy sources. Geothermal power in the U.S. has grown from 500 megawatts in 1975 to over 2,500 installed megawatts today, encompassing over one-third of the world's current total of 6,900 geothermal megawatts. Technological improvements achieved by the Department and its industry partners have spurred this advance and have helped U.S. geothermal companies commit to over \$6.3 billion in domestic and international resource development agreements in the last three years.

A. Estimates of Benefits

At the proposed funding levels the Geothermal Energy Program is expected to yield the following quantifiable benefits; these are cumulative benefits assuming a baseline of zero in 1998:

Year	2000	2010	2020

Annual Primary Energy Displaced (Quads)	.02	0.4	1.6
Carbon Equivalent Emissions Reduction (MMT)	.48	9.3	33

B. Performance Goals

The following representative annual performance measures will be used by the Geothermal Energy Program to track its commitment to lower the life-cycle cost of producing electric power and increase the rate of adoption of geothermal heat pumps (GHPs), thereby reducing the emission of greenhouse gases by displacing conventional electricity sources.

FY 1997 Performance Measures

SOLAR AND RENEWABLE ENERGY

GEOHERMAL (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

- Transfer one new conventional drilling technology improvement to industry.
- Cost-share with industry one project to demonstrate improved energy conversion systems.
- Co-sponsor ten utility cost-shared GHP demonstration projects.

FY 1998 Performance Measures

- Reduce conventional well-drilling costs by 10%.

FY 1999 Performance Measures

- Initiate field tests of revolutionary drilling technology that will reduce costs by an additional 20 percent.
- Generate programs with utilities and industry to install 40,000 new GHP units.

FY 2000 - 2005 Performance Measures

- Reduce typical geothermal plant maintenance and operating costs by 10%.
- Completed demonstrations of economic benefits of Kalina and Biphase electric generating systems.
- Transfer technology that will reduce geothermal exploration costs by up to 15 percent.

SOLAR AND RENEWABLE ENERGY

GEOTHERMAL (Cont'd)

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
Geothermal Electric R&D and Deployment	\$23,148	\$22,651	\$29,500	\$6,849	30%
Geothermal Heat Pump Deployment	<u>6,482</u>	<u>6,400</u>	<u>3,500</u>	<u>-2,900</u>	<u>-45%</u>
Total, Geothermal Energy R&D	<u>\$29,630</u>	<u>\$29,051</u>	<u>\$33,000</u>	<u>\$3,949</u>	<u>14%</u>

III. Performance Summary - Accomplishments:

Geothermal Electric R&D and Deployment	FY 1997	FY 1998	FY 1999
<p>Exploration and Production Technology:</p> <p>FY 1997 - Shared with industry the cost to confirm the value of new geothermal exploration techniques.</p> <p>FY 1998 - Initiate development of a technology that can map the characteristics of fractures in subsurface geothermal rock formations; complete development of computer techniques to derive critical geothermal reservoir parameters from relatively inexpensive seismic data.</p> <p>FY 1999 - Conduct peer-reviewed research to image fractured reservoirs using new 3D-seismic techniques. Develop technology and interpretation methods to characterize hot, fluid-filled fractures using borehole electromagnetics. Expand testing and verification of new chemical tracers to follow injected water through geothermal reservoirs. Cost-share discovery and confirmation of new geothermal resources with high developmental potential in the vicinity of population centers. Conduct peer-reviewed, industry-directed research into "hot dry rock" methods of enhanced heat recovery.</p>	\$9,818	\$9,987	\$13,500

SOLAR AND RENEWABLE ENERGY

GEOTHERMAL (Cont'd)

Geothermal Electric R&D and Deployment (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Drilling Technology: 1997 - Sponsored projects to develop new drilling technologies that can cut geothermal costs.</p> <p>1998 - Work with industry to field test synthetic diamond bits that can drill effectively in hot, hard rock formations. Begin development of fiber optic technology that can transmit information at high rates from the bottoms of very hot geothermal wells to the ground surface. Conduct cooperative R&D with DOE/Fossil Energy in advanced drilling technology.</p> <p>1999 - Investigate components needed for advanced drilling systems in high-temperature, high-pressure conditions in crystalline rocks. Test and verify advantages of synthetic-diamond drill bits, high-speed, top-drive drilling systems, reverse circulation of drilling fluid, and advanced computer-memory logging tools.</p>	\$5,030	\$6,900	\$8,000
<p>Energy Conversion Technology: 1997 - Shared with industry the development costs for an advanced system for controlling non-condensable gases in geothermal fluids; completed design of a technically advanced geothermal demonstration power plant utilizing a total flow expander.</p> <p>1998 - Begin construction of a multi-megawatt 50% cost-shared geothermal demonstration power plant based on advanced heat recuperation technology. Cost-share demonstration of a small-scale geothermal power module at a remote location. Complete demonstration of a 1-MW total flow expander with 50% cost-share from industry. When completed, this system will provide industry with a more competitive technology for production of electricity from high (>350° F) geothermal resources.</p>			

SOLAR AND RENEWABLE ENERGY

GEOTHERMAL (Cont'd)

Geothermal Electric R&D and Deployment (Cont'd)	FY 1997	FY 1998	FY 1999
Energy Conversion Technology (Cont'd): 1999 - Conduct field experiments on improved-efficiency geothermal generators, including small-scale power modules, to significantly increase electrical power output. Test high-efficiency cooling systems and computer controlled chemical inhibitors. Demonstrate biochemical conversion of waste to economic byproducts at an operating geothermal power plant.	\$5,900	\$5,476	\$8,000
Hot Dry Rock Fenton Hill Experimental Site: 1997 - Decommissioned the hot dry rock site at Fenton Hill; prepared final report. 1998 - No activities planned. 1999 - No activities planned.	\$400	\$0	\$0
Site Development Activities: 1997 - With state, county, and industry partners, began operation of the prototype pipeline to carry treated sewage effluent to The Geysers, and studied a second such system, to convey effluent from Santa Rosa. 1998 - No activities planned. 1999 - No activities planned.	\$2,000	\$0	\$0

SOLAR AND RENEWABLE ENERGY

GEOTHERMAL (Cont'd)

Geothermal Electric R&D and Deployment (Cont'd)	FY 1997	FY 1998	FY 1999
Ocean R&D: 1997 - No activities funded. 1998 - Continue operation of the ocean thermal energy conservation system at Keahole Point, Kona, Hawaii. 1999 - No activities planned.	\$0	\$288	\$0
TOTAL Geothermal Electric R&D and Deployment	\$23,148	\$22,651	\$29,500
Geothermal Heat Pump Deployment			
Geothermal Heat Pumps: 1997 - Initiated three new cost-shared regional programs; completed load and performance data gathering; verified sales of 120,000 geothermal heat pump systems. 1998 - Work with industry consortium to accelerate widespread consumer acceptance of geothermal heat pump technology. 1999 - Last year of funding. Conduct research to improve efficiency of ground-loop heat exchangers, to increase reliability, and to improve grouting of wells. Develop improved training methods for installers. Increase deployment of technology to mitigate climate change.	\$6,482	\$6,400	\$3,500
TOTAL Geothermal Heat Pump Deployment	\$6,482	\$6,400	\$3,500
TOTAL Geothermal	\$29,630	\$29,051	\$33,000

SOLAR AND RENEWABLE ENERGY

GEOTHERMAL (Cont'd)

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

<u>Geothermal Electric R&D and Deployment:</u> The increase in funds reflects a change in research priorities, including: conducting peer-reviewed and industry directed research on imaging of geothermal reservoirs and improved methods of extracting heat from hot dry rock; testing of new chemical tracers for use in geothermal reservoirs; testing of advanced technology drill bits and drilling systems; conducting field experiments on improved geothermal electric generators; and testing of high-efficiency cooling systems.	\$6,849,000
<u>Geothermal Heat Pump Deployment:</u> The decrease in funds reflects the expected increase in industry cost-shared funding.	\$-2,900,000
Total Funding Change, Geothermal	<u><u>\$3,949,000</u></u>

SOLAR AND RENEWABLE ENERGY

HYDROGEN RESEARCH AND DEVELOPMENT

(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives: The mission of the Hydrogen Research and Development program is to enhance and support the development of cost competitive hydrogen technologies and systems that will reduce the environmental impacts of energy use and enable renewable energy resource penetration into the U.S. energy mix. Hydrogen, produced using renewable energy power systems, can be stored and transported to U.S. energy end-use markets (utility, transportation, industrial) and converted directly to electricity in a fuel cell or into thermal energy via combustion. To achieve its mission, the hydrogen program has four strategies: (1) expand the use of hydrogen in the near-term by working with industry, including hydrogen producers, to improve efficiency, lower the emissions, and lower the cost of technologies that produce hydrogen from natural gas and to introduce renewable-based production options; (2) work with fuel cell manufacturers to develop hydrogen-based electricity storage and generation systems that will enhance the introduction and penetration of distributed, renewable-based utility systems; (3) coordinate with the Department of Defense and DOE's Office of Transportation Technologies to demonstrate safe and cost-effective fueling systems for hydrogen vehicles in urban non-attainment areas and to provide onboard hydrogen storage systems; and (4) work with the National Laboratories to lower the cost of technologies that produce hydrogen directly from sunlight and water.

The FY 1999 request continues to implement the program outlined in the Department's Hydrogen Multiyear Plan and recommended by the Hydrogen Technical Advisory Panel. The efforts are directed towards development of critical technologies needed for the introduction of hydrogen into the energy infrastructure. In accordance with the Hydrogen Future Act of 1996 and the Energy Policy Act of 1992, systems using renewable energy sources to produce hydrogen are one of the highest priorities for development, testing, and evaluation. This program utilizes the core competency of the National Laboratories, universities, and industry to develop and demonstrate the processes and technologies needed to produce, store, transport, and utilize hydrogen safely in various applications. In FY 1999, efforts will proceed with awards for a cost-shared joint venture with industry to design and fabricate a near-term stand-alone hydrogen production and refueling station, for the installation and operation of an integrated Proton Exchange Membrane (PEM) fuel cell electric and hydrogen generation system; support of hydrogen fuel cell vehicle program; cost-shared development with industry of cost efficient processes for the conversion of methane to hydrogen; biomass gasification for hydrogen production; and completion of the Palm Desert new electric vehicle program. In addition, activities will focus on increasing the efficiency of photolytic and thermal

SOLAR AND RENEWABLE ENERGY

HYDROGEN RESEARCH AND DEVELOPMENT (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

production methods for hydrogen, reducing the cost of hydrogen storage through cost-shared development projects with industry, and demonstrating the environmental benefits of using hydrogen.

A. Estimates of Benefits:

The estimated benefits are based on a contribution of hydrogen fuel cells to the nation's future electricity generation mix. Hydrogen fuel cells are expected to account for 36 GW, a 4.2% share of the projected U.S. total by the year 2020. Between 2016-2020, the Renewable Energy Penetration Model projects installation of an additional 21 GW of fuel cells, 27% of all new electric capacity.

These are cumulative benefits assuming a baseline of zero in 1996.

	2000	2010	2020
Annual Primary Energy Displaced (Quads)	0.00	0.01	1.2
Annual Displaced Electricity Value (\$0.07/kWh)	\$7 M	\$73 M	\$8,100 M
Carbon Equivalent Emissions Reductions (MMT)	0.02	0.15	17

B. Goals

- 2000 - Non-energy (capital and operating) cost of electricity from baseload renewable options will be reduced to 5 cents/kWh.
- 2002 - Non-energy (capital and operating) cost of electricity from hydrogen-based storage systems will be lowered to 5 cents/kWh.
- 2002 - Plant cost of renewable hydrogen produced from sunlight and water not using electrolysis will be reduced to 9-11 \$/MMBtu.
- 2002 - The cost of hydrogen delivered to a vehicle at pressure will be reduced to 12-15 \$/MMBtu.

SOLAR AND RENEWABLE ENERGY

HYDROGEN RESEARCH AND DEVELOPMENT (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

- 2005 - Hydrogen use increases from 0.3Q/yr (as a chemical feedstock to produce reformulated gasoline), to 0.6Q/yr (as a transportation fuel and chemical feedstock), the equivalent of 54 million barrels of oil increase.
- 2010 - Deployment of new hydrogen production technologies to convert natural gas for fuel cell applications will reduce emissions by: 61,000 tons per year NO_x, 1,000,000 tons per year CO, and 46 million tons per year CO₂.
- 2010 - Biomass and municipal solid waste gasification contribute the equivalent of 0.2Q/yr production capacity of hydrogen.
- 2020 - Hydrogen-based systems will begin to displace fossil fuels in utility, building, and vehicle applications leading to 1 Quad use.
- 2025 - Renewable energy based hydrogen production will contribute the equivalent of 10Q/yr in the primary energy market.

C. Performance Measures

FY 1997 Performance Measures

- Operated experimental engineering evaluation test bed that integrates Proton Exchange Membrane (PEM) fuel cells with metal hydride storage and delivery system. Collected data on hydride storage cost and performance, safety, refueling, efficiency, maintenance complexity, and sensors.
- Constructed and demonstrated a process development unit (PDU) size bioreactor to test the feasibility of producing hydrogen from oxygen tolerant algal mutants on a continuous basis.
- Designed a process development unit to demonstrate sorbent enhanced steam methane reforming scaled to 0.1 MM SCFD of hydrogen.

SOLAR AND RENEWABLE ENERGY

HYDROGEN RESEARCH AND DEVELOPMENT (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

- Completed the design of a pure hydrogen-fueled phosphoric acid fuel cell for stationary power generation.

FY 1998 Performance Measures

- Complete 9 case studies for near-term hydrogen opportunities, biomass gasification, and hydrogen filling stations.
- Complete phase one of hydrogen feasibility study solicitation to commercialize hydrogen production technologies.
- Complete preliminary economic evaluation of Ion Transport Membrane (ITM) SynGas process to produce hydrogen from natural gas.
- Complete phase one of renewable/hydrogen utility system solicitation.

FY 1999 Performance Measures

- Operate new hydrogen-fueled (PEM Fuel Cell) electric vehicle in city driving.
- Demonstrate certifiable hydrogen storage for vehicles.

FY 2000 - 2005 Performance Measures

- Demonstrate integration of low temperature biological catalyze water gas shift reactor with biomass pyrolysis for hydrogen production in a PDU scale.

SOLAR AND RENEWABLE ENERGY

HYDROGEN RESEARCH AND DEVELOPMENT (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

- Complete construction, commissioning, and start-up of a 500 thousand standard cubic foot per day ion transport membrane syngas engineering prototype.
- Demonstrate a 10 kW PEM fuel cell battery pack for powering small-scale appliances.
- Demonstrate integrated 50 kWe PEM cell with natural gas reformer to evaluate commercial viability of the technology.
- Demonstrate stand-alone 3-5 kWe PEM fuel cell fueled with reformat.

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
Hydrogen Research and Development	<u>\$ 14,809</u>	<u>\$ 16,003</u>	<u>\$ 24,000</u>	<u>\$ 7,997</u>	<u>50%</u>
Total, Hydrogen Research and Development	<u><u>\$ 14,809</u></u>	<u><u>\$ 16,003</u></u>	<u><u>\$ 24,000</u></u>	<u><u>\$ 7,997</u></u>	<u><u>50%</u></u>

SOLAR AND RENEWABLE ENERGY

HYDROGEN RESEARCH AND DEVELOPMENT (Cont'd)

III. Performance Summary - Accomplishments:

Hydrogen Research and Development	FY 1997	FY 1998	FY 1999
<p>Core Research & Development: Activities will focus on increasing the efficiency of photolytic and thermal processes to produce hydrogen, increase the performance of hydrogen storage technologies, and demonstrate improvements in emissions and total system efficiencies.</p> <p>I. Production: Efforts are focused on reforming hydrocarbon fossil fuels and purification, biomass gasification and photolytic processes to produce hydrogen at 6-9 \$/MMBtu.</p> <p>Distributed Reforming/Purification: 1997 - Demonstrated proof-of-concept reversible Hydrogen Bromide (HBr) fuel cell for hydrogen production and power generation. Demonstrate Sorbent Enhanced Reforming (SER) cyclic efficiency in sub-scale testing. Award contract for ion transport membrane for more efficient production of hydrogen from carbonaceous feedstocks.</p> <p>1998 - Demonstrate SER process development unit for optimization, scale-up, and integration. Complete preliminary economic evaluation of ITM SynGas process.</p> <p>1999 - Proceed with scale-up and integration of SER process system. Make a go/no-go decision for Phase 2 of ITM SynGas.</p>	\$1,290	\$1,600	\$3,050

SOLAR AND RENEWABLE ENERGY

HYDROGEN RESEARCH AND DEVELOPMENT (Cont'd)

Hydrogen Research and Development (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Biomass Gasification: 1997 - Completed characterization of gasification products from Texaco gasifier using solid waste as the feedstock.</p> <p>1998 - Complete scale-up for hydrogen production efficiency and obtain process characterization data. Award contract for design and construction of a cost-shared biomass to hydrogen gasifier system.</p> <p>1999 - Continue development of catalytic technology to reform gasification products to hydrogen. Test PDU with selected catalyst #1. Fabricate scale-up of super-critical gasification reactor for production of hydrogen from high moisture content agricultural and other wastes.</p>	\$1,090	\$1,357	\$2,030
<p>Photolytic Processes: 1997 - Improved Silicon Carbide (SiC) film performance through modification of alloy coatings with resulting increased hydrogen production and lower overall cost.</p> <p>1998 - Develop amorphous silicon and hybrid cells for high efficiency, direct solar hydrogen production demonstrations. Complete development of long-life algae system for higher efficiency single photon hydrogen production.</p> <p>1999 - Continue to improve oxygen-tolerance of algae. Scale-up laboratory bioreactors. Demonstrate the overall process for a two-stage bioprocessor using filamentous cyanobacteria. Select final solar cell configuration and demonstrate greater than 3000 hour cell lifetime in electrolyte for a 6 square inch photoelectrochemical module.</p>	\$1,975	\$1,780	\$1,930

SOLAR AND RENEWABLE ENERGY

HYDROGEN RESEARCH AND DEVELOPMENT (Cont'd)

Hydrogen Research and Development (Cont'd)	FY 1997	FY 1998	FY 1999
<p>II. Storage: Efforts are focused on developing storage materials and systems that exceed 5.5% by weight hydrogen for utility and transportation applications.</p> <p>1997 - Assembled and demonstrated proof-of-concept lightweight magnesium, aluminum, copper alloy exceeding 5% by weight of hydrogen and transfer technology to industry.</p> <p>1998 - Select optimum carbon-based adsorbent material, fabricate and characterize prototype storage system to determine practical feasibility.</p> <p>1999 - Assemble and demonstrate a complete hydride system with 5% by weight hydrogen capacity at an operating temperature below 150° C. Demonstrate 50% production yield for single walled carbon nanotubes in a continuous process. Demonstrate 4% by weight hydrogen uptake on carbon nanotubes at room temperature.</p>	\$2,105	\$1,848	\$2,090
<p>III. Utilization: Efforts are focused on developing and demonstrating end-use technologies that are safe, and have near-zero or zero emissions with an overall efficiency greater than 45%.</p> <p>1997 - Complete the design of a pure hydrogen fueled phosphoric acid fuel cell for stationary power generation.</p> <p>1998 - Assemble 5 kW prototype proton exchange membrane fuel cell using advanced manufacturing processes.</p>			

SOLAR AND RENEWABLE ENERGY

HYDROGEN RESEARCH AND DEVELOPMENT (Cont'd)

Hydrogen Research and Development (Cont'd)	FY 1997	FY 1998	FY 1999
III. Utilization (Cont'd): 1999 - Scale-up PEM manufacturing process using metal plates. Complete technology transfer of low-cost fiber-optic hydrogen gas leak detector.	\$1,265	\$390	\$1,000
TOTAL Core Research & Development	\$7,725	\$6,975	\$10,100
Technology Validation: Efforts are focused on developing cost-shared joint ventures with industry on hydrogen refueling stations, vehicle storage, reversible fuel cells and high temperature, advanced fuel cells. 1997 - Awarded contracts for cost-shared development of hydrogen storage systems and hydrogen production infrastructure to support Proton Exchange Membrane (PEM) fuel cell distributed utility and vehicle activities. 1998 - Initiate the development of hydrogen refueling stations. Complete phase I of Hydrogen Feasibility Study Solicitation to commercialize hydrogen production technologies with industry and enter into design and construction phase for three ventures. Additional funds (\$3,000) are for Russia/American Fuel Cell Consortium PEM fuel cell activities which include solicitations for cost-sharing arctic demonstration projects, laboratory and university technical assistance, and an organization and planning workshop. 1999 - Fabricate high-pressure hydrogen storage tanks for vehicles. Continue with construction of one cost-shared joint-venture with industry on hydrogen options from solicitation.			

SOLAR AND RENEWABLE ENERGY

HYDROGEN RESEARCH AND DEVELOPMENT (Cont'd)

Hydrogen Research and Development (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Technology Validation (Cont'd): Award cooperative agreement for hydrogen fueling station for fleet vehicles and/or buses.</p> <p>Award Phase II of Hydrogen Renewable/Utility Solicitation to include hydrogen production technology with fuel cell electric generation for utility systems, on a 50/50 cost-shared basis with industry.</p> <p>Award contract for the installation and operation of a 50 kWe Proton Exchange Membrane (PEM) fuel cell system to produce electricity and also generate hydrogen. Award contract for stand-alone power generation system using 3 to 5 kWe Proton Exchange Membrane fuel cells fueled by reformat.</p>	\$3,710	\$6,354	\$11,420
<p>Analysis and Outreach: Conduct portfolio analyses to verify hydrogen technologies can meet cost and performance goals, assist the private sector in determining steps to create hydrogen energy markets. Increase awareness of the benefits of hydrogen and encourage participation of stakeholder groups in Program Review Meetings.</p> <p>1997 - Demonstrated advanced computational model to predict hydrogen production from gasification and pyrolysis. Developed and implemented hydrogen curriculum for Los Angeles schools, including upgrading of the CD to cover all renewable-energy-based hydrogen production technologies.</p> <p>1998 - Expand hydrogen codes and standards activities to integrate data from the U.S. and foreign countries. Complete 5-year implementation plan. Complete hydrogen infrastructure report for a prototype city.</p>			

SOLAR AND RENEWABLE ENERGY

HYDROGEN RESEARCH AND DEVELOPMENT (Cont'd)

Hydrogen Research and Development (Cont'd)	FY 1997	FY 1998	FY 1999
Analysis and Outreach (Cont'd): 1999 - Prepare plausible near-term technology road maps for hydrogen corridor activities. Define market and strategic criteria to guide R&D investments to enhance global competitive leadership. Define benefits costs of building applications of fuel cells for distributed utility generation.			
	\$3,374	\$2,674	\$2,480
TOTAL Hydrogen Research and Development	\$14,809	\$16,003	\$24,000

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Hydrogen Research and Development: The increased funding will accelerate research and development on methods for production, storage, and utilization of hydrogen, and permit three cooperative agreements to be awarded. One award will include a vehicle fueling station and support cost-shared renewable/utility systems projects. The others will enable the installation and operation of a 50 kWe PEM fuel cell electric and hydrogen generation system and a 3 to 5 kWe stand-alone generation system.

\$7,997,000

Total Funding Change, Hydrogen Research and Development

\$7,997,000

SOLAR AND RENEWABLE ENERGY

HYDROPOWER DEVELOPMENT

(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives: The mission of the U.S. Department of Energy's Hydropower Program is to improve the technology base for, and the societal and environmental benefits of hydropower use, by conducting and coordinating research and development with industry and other Federal agencies. The primary goal is to develop advanced technology which will allow the nation to maximize the use of its hydropower resources, while minimizing adverse environmental effects. Improved environmental performance will help meet regulatory conditions in licensing and relicensing and help preserve hydropower's contribution to U.S. energy production, as well as facilitate development of an additional 28,000 MW at sites throughout the U.S..

Resource Assessment

The program conducts standardized hydropower resource assessments for each state. These assessments utilize environmental attributes of each hydropower site to calculate a relative development suitability factor for a project.

- Forty-one states have been completed. Assessments for the remaining states to be completed by the end of FY 1998.

Advanced Hydropower Turbine System

Objectives are to design, develop, build, and test environmentally friendly advanced hydropower turbine systems. The program will proceed from the conceptual design phase completed in 1997 and, in coordination and partnership with other public and private stakeholders, will:

- Develop biological criteria for advanced turbine design.
- Develop advanced techniques to visualize and simulate fish passage.
- Develop fully engineered designs, construct and test models.
- Build and test full-scale prototypes of the most promising models in actual operating hydropower plants.

SOLAR AND RENEWABLE ENERGY

HYDROPOWER DEVELOPMENT (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd):

At the proposed funding levels the Hydropower Program is expected to yield the following performance goals and benefits:

A. Estimates of Benefits

The primary benefit will be the development and demonstration of turbine technology which will meet dissolved oxygen (≥ 6 mg/liter) and other water quality standards, and reduce fish mortality from turbine passage to less than 2 %.

B. Performance Goals

Performance Measures for FY 1999:

- Initiate experiments to establish biologically-based performance criteria for advanced turbines.
- Initiate design of instrumentation for real-time visualization and accurate simulation of fish passage through turbines.

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
Hydropower Development	\$ 973	\$ 739	\$ 4,000	\$ 3,261	441%
Total, Hydropower Development	\$ 973	\$ 739	\$ 4,000	\$ 3,261	441%

SOLAR AND RENEWABLE ENERGY

HYDROPOWER DEVELOPMENT (Cont'd)

Hydropower Development	FY 1997	FY 1998	FY 1999
Hydropower: 1997 - Completed four conceptual designs for advanced hydropower turbines. Complete resource assessments for ten additional states. 1998 - Complete resource assessment for final nine states. Begin laboratory studies of the effects of shear and turbulence stresses on turbine-passed fish to establish performance criteria for advanced turbines. 1999 - Begin design of instrumentation for real-time visualization and accurate simulation of fish passage through turbines.			
	\$973	\$739	\$4000
TOTAL Hydropower Development	\$973	\$739	\$4,000

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Hydropower Development: The Hydropower Program is being expanded in response to both issues the industry is facing as many of its facilities face relicensing and to the Administration's Climate Change Technology Initiative. The increased funding will initiate Phase II of the development of a fish-friendly turbine, taking it from a conceptual to an engineering design and the subsequent development of an actual prototype turbine.

\$3,261,000

Total Funding Change, Hydropower

\$3,261,000

SOLAR AND RENEWABLE RESOURCE TECHNOLOGIES

RENEWABLE INDIAN ENERGY RESOURCES PROGRAM

(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives: The FY 1998 Energy and Water Development Appropriations Report language for Solar and Renewable Energy designated funding for Renewable Indian Energy Resource projects. No funding is requested for FY 1999.

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
Renewable Indian Energy Resources Program . .	<u>\$ 4,000</u>	<u>\$ 3,939</u>	<u>\$ 0</u>	<u>\$ -3,939</u>	<u>-100%</u>
Total, Renewable Indian Energy Resources	<u>\$ 4,000</u>	<u>\$ 3,939</u>	<u>\$ 0</u>	<u>\$ -3,939</u>	<u>-100%</u>

III. Performance Summary - Accomplishments:

Renewable Indian Energy Resources Program	FY 1997	FY 1998	FY 1999
Haida Alaska Native Village Corporation's Reynolds Creek Hydroelectric Program: 1997 - Cooperative agreement negotiated and in place. 1998 - Carry out activities under agreement. 1999 - No funding requested.			
	\$1,000	\$0	\$0
Eyak Native Corporation's Power Creek Hydroelectric Project: 1997 - Grant negotiated and in place. 1998 - Award grant and carry out activities under agreement. 1999 - No funding requested.			
	\$2,000	\$1,970	\$0

SOLAR AND RENEWABLE RESOURCE TECHNOLOGIES

RENEWABLE INDIAN ENERGY RESOURCES PROGRAM (Cont'd)

Renewable Indian Energy Resources Program (Cont'd)	FY 1997	FY 1998	FY 1999
Klawock Thorne Bay-Kasaan Electrical Intertie: 1997 - Grant negotiated and in place.			
1998 - 1999 - No funding requested.	\$1,000	\$0	\$0
Old Harbor Hydroelectric Project: 1998 - Grant negotiated and in place.	\$0	\$787	\$0
Upper Lynn Canal Regional Intertie: 1998 - Grant negotiated and in place.	\$0	\$985	\$0
Scammon Bay Hydroelectric Feasibility Studies: 1998 - Grant negotiated and in place.	\$0	\$99	\$0
DOE monitoring and technical assistance.	\$0	\$98	\$0
TOTAL Renewable Indian Energy Resources Program	\$4,000	\$3,939	\$0

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Renewable Indian Energy Resources Program: FY 1998 programs underway and funded. No funding requested for any additional activities in FY 1999. \$-3,939,000

Total Funding Change, Renewable Indian Energy Resources Program **\$-3,939,000**

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE

(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives: The mission of the Electric Energy Systems and Storage Program is to develop, in collaboration with industry, advanced power delivery technologies that will: 1) increase the efficiency, flexibility and capacity of the Nation's electric power systems; 2) increase utilization of renewable energy sources; 3) fulfill requirements of customers and utilities in the new competitive environment. These technologies will enable high quality, cost-effective, reliably-delivered power.

High Temperature Superconductivity (HTS) and Energy Storage R&D programs will create energy efficient technologies that will enhance renewable penetration, enhance power quality and reliability, increase system capacity, enhance asset utilization and increase U.S. industrial competitiveness. Electricity-related institutional and environmental issues that affect the implementation of efficient and cost-effective power delivery are addressed by the Electric and Magnetic Fields (EMF) and Climate Challenge Programs.

HIGH TEMPERATURE SUPERCONDUCTIVITY: DESCRIPTION, BENEFITS, AND PERFORMANCE MEASURES:

The Department leads the national effort to capture the energy-saving potential of superconductivity--the ability of certain materials to be high-capacity carriers of electricity without having the resistance losses inherent in normal conductors, such as copper. The program has mobilized the resources of U.S. industry, national laboratories, and universities to accomplish two major technological goals: solving the difficult problem of manufacturing electrical wires from the family of brittle ceramic high temperature superconducting materials discovered in 1986 while, in parallel, creating designs of superefficient electrical systems such as motors, transmission cables, generators, transformers and current limiters that use these wires.

Superconductivity has the potential to bring about an energy revolution as profound as the impact fiber optics has had on communication. The information superhighway has largely been constructed by replacing copper wires with much higher-capacity fiber optic wires. Superconducting wires, with 100 times the carrying capability of copper wires, will result in transmission cables with 5 times the capacity of conventional cables. Also, motors, generators, and transformers can be built that are half the size and weight of conventional systems. Furthermore, these advanced systems will have only half the energy losses of the conventional alternatives.

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd)

The underlying knowledge base needed for the success of the above industry-led projects is provided by the Strategic Research part of the program. The Second Generation Wire Initiative evolved from five years of strategic research that achieved world record performance breakthroughs in short wire samples. Strategic research will continue on wire processing as well as exploratory research on transformers, magnetic separation, and other systems. In addition, analysis relating to restructuring of the electric utility industry will be conducted on issues associated with integration of superconducting systems into an increasingly competitive industry framework.

Superconductivity Partnership Initiative (SPI) The SPI is a focused team effort by the DOE and industry to design early prototypes of utility technologies such as motors, generators, and power cables. Phase 1 (small scale design) efforts were successfully completed in FY 1996 and set world records on motors, generators, power cables and current limiters. Phase 2 (full scale design) projects were selected in FY 1997 for motors, power cables, and current limiters. A second SPI solicitation in FY 1998 will yield projects for design of other critical utility components, such as transformers.

Second Generation Wire Initiative Research breakthroughs were made at Los Alamos and Oak Ridge National laboratories in FY 1995 and FY 1996 that promise to dramatically improve performance and cost of high temperature superconducting wires. The "first generation" wires currently supporting SPI design activities may not meet future commercialization requirements. These requirements can be met through DOE and industry aggressively pursuing the lab breakthroughs in this initiative. Continued parallel improvement in existing wire performance is needed and is supported under the SPI.

Strategic Research This cutting edge research at national labs, private companies, and universities has led to much of the success achieved so far. The breakthroughs now being exploited in the Second Generation Wire Initiative were achieved in this activity which typically includes 20 cooperative research and development agreements with private companies. Alternative wire processing research is done as well as fundamental research on transformers, magnetic separation equipment, and other end-use systems.

A. Estimates of Benefits

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd)

At the proposed funding level, the Superconductivity program is expected to yield the following quantifiable benefits; these are cumulative benefits assuming a baseline of zero in 1996:

Superconductivity	2000	2010	2020
Direct Oil Displaced (million barrels per year)	0	0.05	0.91
Annual Displaced Energy Displaced (Q)	0	0.02	0.2
Annual Displaced Electricity Value (\$M)	0	240	1000
Carbon Equivalent Emissions Reductions (MMT)	0	0.05	0.07

B. Performance Measures

Success is measured by improving the ability to carry large currents and lowering the cost of superconducting electric wire, creating designs for powerful, high-efficiency energy systems using these wires, performing world-class research, and keeping the U.S. in a position of leadership in advancing this new technology.

FY 1997 Performance Measures

- The status and prospects of the U. S. superconductivity research program were evaluated against those of major competitors in Japan and Germany.
- Expanded industry-led program to exploit processing breakthroughs at Los Alamos and Oak Ridge that will lead to a second generation of HTS wire being commercially available in 2002 with significantly improved performance and lower cost.
- Designed HTS motors that set new world performance records.

FY 1998 Performance Measures

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd)

- Meet current limiter requirements and finish current limiter project.
- Select new Superconductivity Partnership Initiative project teams in competitive action.
- Reach initial scale-up requirements of Los Alamos/Oak Ridge wire processing breakthroughs.

FY 1999 Performance Measures

- Make awards for new Superconductivity Partnership Initiative projects (3 anticipated).
- Build world's first high field (1.0 Tesla) magnet that operates at liquid nitrogen temperature.
- Improve the ability of HTS materials to carry high electrical currents by experimentally determining the impacts of processing steps used in manufacture. The lack of such understanding now limits the performance of both first and second generation HTS wires.

FY 2000-2005 Performance Measures

- Reach HTS wire cost goal of \$0.01 per ampere-meter (now over \$1.00).
- Reach HTS wire performance goal of 100 times the current carrying capacity of copper wires.
- Meet final goals of Superconductivity Partnership Initiative power cable project.
- Meet final goals of Superconductivity Partnership Initiative motor project.
- U. S. industry is positioned to begin commercialization of a new generation of advanced HTS energy sector products.

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd)

ENERGY STORAGE: DESCRIPTION, BENEFITS, AND PERFORMANCE MEASURES

Utilities are now planning how to use technologies such as energy storage and renewable generation in a deregulated, competitive, and environmentally conscious business climate. Energy storage is an option that, when fully developed, can help utilities provide quality power and ensure reliable delivery of electricity for all customers. Energy storage technologies can also play an important role in improved stability of the nation's transmission and distribution system. Furthermore, energy storage can help decrease utility costs, enhance asset utilization, defer upgrades, and increase flexibility and efficiency. Energy storage also has a vital role to play in increasing the value of intermittent renewable generation by making these resources available regardless of when they are generated. Given declining private investment in utility R&D, federal investment in storage R&D will impact reliability and cost in wide areas of the country and for large industrial sectors, and can accelerate adoption of sustainable energy technologies.

The mission of the Energy Storage Systems (ESS) Program is to conduct research and development (R&D), leveraged by U.S. industry, to stimulate the widespread use of energy storage systems for renewable energy generation and other electric system applications. The Program consists of systems integration, component R&D, and analysis elements. As energy storage technologies are implemented by utilities, independent power producers, renewable generators, and end-use customers, major national economic and environmental benefits will be realized. The use of intermittent renewables (i.e., wind and solar) will be enhanced significantly by the development of low-cost-highly integrated storage systems (e.g., there is a projected year 2000 market of \$4B for use with photovoltaic systems alone). Storage systems will mitigate the impact of reduced power quality due to deregulation and will help reduce power sector costs and carbon emissions.

Competitive market forces under industry restructuring will require operation of the power system in ways for which it was not designed, which will at the same time require integration of emerging technologies. These changes will need to be made at the lowest possible cost while maintaining high reliability. Energy storage systems provide utilities with flexible, virtually instantaneous (one-quarter cycle) power and energy for multiple power system applications: Prototype battery energy storage installations are currently being field tested for integrated power quality, renewables and productivity applications. Flywheels, power electronics, high energy density batteries, Superconducting Magnetic Energy Storage (SMES), modular transportable systems, and control systems will be developed.

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd)

A. Estimates of Benefits

At the proposed funding level, the Energy Storage Systems R&D program is expected to yield the following quantifiable benefits; these are cumulative benefits assuming a baseline of zero in 1998:

	2000	2010	2020
Installed Energy Storage (GW)	.6	9	30
Savings to U.S. Consumers (Billion \$)	.5	20	57

The gigawatts of energy storage systems installed include both utility and end-user applications, based on a recent market study by Frost & Sullivan. These benefits include: 1) capacity deferral, area/frequency regulation, and renewables integration applications; 2) transmission and distribution facility deferrals, transmission line stability, and voltage regulation; and 3) customer demand peak shaving and reliability/power quality. The value of these services to utilities and customers varies greatly and is being quantified on a case-by-case basis.

The deregulation of utilities is bringing about a period of change and uncertainty; deferral of retrofits and upgrades through the increased use of storage may be a preferred strategy until the business climate has stabilized. The primary goal of the Energy Storage Systems program is to provide advanced technology to increase the reliability and reduce the environmental impact of generation, transmission, and distribution in the U.S. electric delivery system.

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd)

B. Performance Measures

FY 1997 Performance Measures

- Develop flexible storage systems which meet the cost goal of \$900 per kW.
- Increase industry cost-share to 50% in new prototype development projects.

FY 1998 Performance Measures

- Demonstrate transportable power quality systems; power quality problems cost U.S. industry \$400B/year.
- Increase the energy available in a battery storage system from 1.5 to 3 kWh/square foot.

FY 1999 Performance Measures

- Develop factory-integrated renewable generation and storage systems under the Storage 2000 Initiative, a joint DOE/industry initiative to accelerate technology development for emerging needs in a restructured electricity marketplace.
- Develop critical storage components such as power conditioning systems and controls in a cost-shared program with industry.

FY 2000-2005 Performance Measures

- Increase the amount of new energy storage installed on utility networks by 500 MW.
- Develop flexible storage systems which meet the cost goal of \$800 per kW.
- Increase the energy available in a battery storage system from 1.5 to 5 kWh/square foot.

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd)

- Develop improved power electronics and controls for integrated storage systems with improved flexibility that can meet the needs of batteries, flywheels, SMES and renewable generation sources.
- Test advanced battery energy storage systems at utility sites.
- Install storage system to address power quality problems at utility substations.

ELECTRIC AND MAGNETIC FIELDS: DESCRIPTION, BENEFITS, AND PERFORMANCE MEASURES:

The Electric and Magnetic Fields R&D program manages a portfolio of coordinated health effects research and exposure measurements that will enable the National Institute of Environmental Health Sciences (NIEHS) to assess the risk to human health from exposures to electric and magnetic fields that are associated with the generation, delivery, and use of electricity. It also supports communication efforts to keep the public and other decision makers informed about this issue. This portfolio consists of two coordinated and interdependent subprograms: the EMF Biological Mechanisms Research program and the five-year EMF Research and Public Information Dissemination program. Both programs are focused on providing information for risk assessment. FY 1998 is the final year for the Department of Energy's EMF research efforts.

A. Estimates of Benefits

Private sector sources estimate that the public concern about uncertainty over whether exposure to electric and magnetic fields (EMF) causes health effects already costs the Nation more than \$1 billion per year. Some studies suggest, but have not proven, that higher magnetic field exposures from proximity to power lines and electrical equipment result in an increase in the incidence of diseases such as leukemia, brain tumors, breast cancer, and Alzheimer's disease. The five-year EMF Research and Public Information Dissemination program and the coordinated EMF Biological Mechanisms Research program will provide the scientific information base for a risk assessment to be performed by The National Institute of Environmental Health Sciences in 1998. This risk assessment, which will

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd)

include results of the completed National Academy of Sciences' EMF Study, should significantly reduce uncertainty on the issue and enable policy makers and the public to make informed decisions.

B. Performance Measures (highlights)

The following performance measures will be used by the Electric and Magnetic Fields (EMF) R&D program to track its commitments to significantly reduce uncertainty on this potential health issue and enable policy makers and the public to make informed decisions.

FY 1997 Performance Measures

- Disseminated current and credible information on the issue, to all stakeholders and other interested parties.
- Initiated small NIEHS grants to fill research gaps and continue evaluation of cellular and hormonal effects.
- National Academy of Sciences' EMF Report completed.

FY 1998 Performance Measures

- Complete planned health effects research and exposure assessments leading to a risk assessment by the National Institute of Environmental Health Sciences in 1998.
- Publish and disseminate a risk assessment (by NIEHS) concerning health effects from exposure to electric and magnetic fields, and document research results.

FY 1999-2002 Performance Measures

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd)

- No activities.

CLIMATE CHALLENGE: DESCRIPTION, BENEFITS, AND PERFORMANCE MEASURES

Partnerships for Technology Introduction: The mission of the Climate Challenge program is to offer encouragement to the electric utility industry to voluntarily reduce, avoid, or sequester greenhouse gas emissions using currently available, cost-effective ("no-regrets") means. The voluntary effort on the part of both the electric utility industry and the Department of Energy is in response to the 1992 Framework Convention on Climate Change treaty. It was formally launched in April 1994 through the signing of a Memorandum of Understanding between all the major electric utility trade associations and DOE. Electric utilities voluntarily sign agreements with DOE that commit them to individualized, flexible plans to achieve reductions. In addition to making reductions in their own operations, utilities can contribute to any of nine industry-wide initiatives which the trade associations have developed in support of Climate Challenge. DOE, in return, makes information more readily available, reports on the progress of the program, and provides a forum that publicly recognizes the utility participants.

A. Estimates of Benefits

The Climate Challenge program offers numerous benefits to the Nation. It:

- demonstrates the value of using voluntary cooperation from industry, rather than traditional command-and-control regulation, to achieve environmental objectives. This program is highly popular with industry as a prudent response to the climate change issue.
- achieves measurable greenhouse gas reductions. As of June 1997, over 600 utilities (accounting for over 70 percent of U.S. electrical generation and current carbon emissions) had either signed individually or participated in 120 agreements with DOE. DOE estimates that these reported commitments will reduce emissions by over 45 million metric tons of carbon equivalent in the year 2000. This estimate is conservative, as it does not include reductions not yet quantified, such as results from the nine industry-wide initiatives.

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

I. Mission Supporting Goals and Objectives (Cont'd)

- raises awareness of the many cost-effective methods available to electric utilities to reduce greenhouse gas emissions, so that greenhouse gas mitigation is a factor considered in utility planning and management.
- spurs the utility industry voluntarily to make investments in new energy-efficient and renewable energy technologies and projects.
- strengthens the U.S. position in the ongoing international climate change negotiations.

B. Performance Measures

FY 1998 Performance Measures

Climate Challenge received no funding in FY 1997.

FY 1998 Performance Measures

- Increase utility participation to 700 utilities.
- Create at least one new Climate Challenge “industry-wide initiative” that will highly leverage common utility action in a climate-friendly area.

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

FY 1999 Performance Measures

- Maintain existing partnership agreements to ensure year 2000 pledged reductions of at least 45 million metric tons of carbon equivalent.
- Expand voluntary industry/government collaboration to reduce greenhouse gases by catalyzing a Climate Change forum with over 600 utility partners to exchange lessons-learned on cost-effectively reducing greenhouse gases.

FY 2000-2002 Performance Measures

- A minimum of 45 MMTCE of greenhouse gas reductions annually is expected post-2000.

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
High Temperature Superconductivity R&D	\$ 19,518	\$ 32,005	\$ 32,000	\$-5	0%
Energy Storage R&D	3,954	3,890	6,000	2,110	54%
Electric and Magnetic Fields R&D	7,906	6,893	0	-6,893	-100%
Climate Challenge	<u>0</u>	<u>0</u>	<u>500</u>	<u>500</u>	<u>100%</u>
Total, Electric Energy Systems and Storage	<u>\$ 31,378</u>	<u>\$ 42,788</u>	<u>\$ 38,500</u>	<u>\$ -4,288</u>	<u>-10%</u>

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

III. Performance Summary - Accomplishments:

High-Temperature Superconductivity R&D	FY 1997	FY 1998	FY 1999
Superconductivity Partnership Initiative: 1997 - Awarded Phase II (full scale design) continuations to motor, power cable, and current limiter projects. 1998 - Awards will be made for new Phase I projects (estimate 3 awards). Successful completion of world-record HTS proof-of-concept cable. 1999 - Awards will be made for new Phase I projects (estimate 3 awards). Current limiter commercialization activities using industry funding.	\$9,500	\$14,200	\$14,000
Second Generation Wire Initiative: 1997 - 1 meter length superconducting wire manufactured using industrial practices. The wire has 20 times the current-carrying capacity of comparable copper wire with no resistance loss. (3 CRADAs) 1998 - 10 meter length will be manufactured. Commitment will be made by industrial partner to build pilot manufacturing plant. (Continue 3 FY97 CRADAs and add 2 more CRADAs). 1999 - World's first high field (1.0 Tesla) magnet will be made which operates at liquid nitrogen temperature.	\$4,768	\$7,900	\$8,000

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

High-Temperature Superconductivity R&D (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Strategic Research:</p> <p>1997 - Design and testing accomplished of a small-scale (1MVA) novel, environmentally benign, more efficient electric utility transformer. Report distributed showing U.S.-based technology has competitive edge but foreign programs devoting larger share of R&D budget in attempt to overtake us.</p> <p>1998 - Initial coils will be made with second generation wires. Research results will continue to support both the Superconductivity Partnership and Second Generation Wire initiatives.</p> <p>1999 - Establish an understanding of the relationship between the microstructure of HTS materials and the ability to carry high electrical currents. The lack of such understanding now limits the performance of both first and second generation HTS wires.</p>			
	\$5,250	\$9,905	\$10,000
TOTAL High-Temperature Superconductivity R&D	\$19,518	\$32,005	\$32,000
Energy Storage R&D			
<p>Storage System Integration:</p> <p>1997 - Systems integration of cost-effective storage resource options for both utilities and end-use consumers. Initiate design of integrated Renewable Generation and Storage (RGS) system (PV/storage), that will reliably provide seamless transfer of power. Initiate Secure Bus project to provide quality power to all customers served by utility substations. Initiate Advanced Battery Energy Storage System (ABESS) transportable power management demonstration.</p>			

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

Energy Storage R&D (Cont'd)	FY 1997	FY 1998	FY 1999
<p>Storage System Integration (Cont'd): 1998 - Formulate new storage technologies and strategies for deregulated systems in response to comprehensive 1997 evaluation (see analysis). Complete testing of transportable power quality system Transportable Battery Energy Storage System (TBESS). Prepare for Secure Bus demonstration in 12-kV substation. Continue ABESS and RGS projects.</p> <p>1999 - Begin fabrication of RGS prototype; define requirements for factory integration of components under the Storage 2000 initiative, a joint DOE/industry initiative to accelerate technology development for emerging needs in a restructured electricity marketplace. Complete TBESS field testing and install at customer site. Install ABESS at test site and evaluate. Complete Secure Bus design.</p>	\$1,829	\$1,965	\$3,000
<p>Key Components for Storage Systems: Develop the key components needed for tomorrow's efficient, low-cost, reliable storage systems.</p> <p>1997 - Initiate evaluation of flywheels and superconducting magnetic energy storage (SMES) storage technologies.</p> <p>1998 - Develop critical Secure Bus components (advanced inverters). Continue to develop advanced storage and electronics.</p>			

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

Energy Storage R&D (Cont'd)	FY 1997	FY 1998	FY 1999
Key Components for Storage Systems (Cont'd): 1999 - Undertake solicitation for development of PV/storage balance of system components for Storage 2000 initiative with PV programs. Initiate development of next-generation, multi-megawatt advanced power conditioning subsystem electronics which provides reliable, low-cost control for large power quality, renewables, integration and peak shaving.	\$1,145	\$1,350	\$2,100
Analysis and Utility Restructuring: Quantify high impact applications and utility requirements for storage systems. High activity level in 1997 will lead to repositioning of program for restructured electricity marketplace. 1997 - Evaluated the storage needs of utilities facing competition in a deregulated power sector. Examined value of storage for renewable energy and hybrid storage applications. 1998 - Examine value of storage in reducing power quality problems and avoiding multi-state power outages. 1999 - Complete quantitative estimates of the potential value of storage in a restructured electricity marketplace for specific high-payoff applications.	\$980	\$575	\$900
TOTAL Energy Storage R&D	\$3,954	\$3,890	\$6,000

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

Electric and Magnetic Fields R&D	FY 1997	FY 1998	FY 1999
<p>Research and analysis related to assessment of possible health effects from exposure to electric and magnetic fields associated with the generation, delivery and use of electricity.</p> <p>1997 - Performed experiments to determine dose effect characteristics of reported EMF hormonal effects and conduct research on cellular processes altered by EMF interactions. Continued intensive research to replicate key findings, using advanced EMF exposure systems at four Government laboratories. Initiated, through NIEHS, a number of small grants to fill research gaps. Continued intensive communication program: maintain EMF infoline; distribute Q&A booklet; and complete brochure about EMF in the workplace.</p> <p>1998 - Complete experiments to identify the biophysical basis for replicable EMF biological effects and relevant EMF exposure parameters. Complete intensive research begun in FY 1996 to replicate key findings, using advanced EMF exposure systems at four Government laboratories. Complete a risk evaluation of potential human health effects from exposure to electric and magnetic fields (by NIEHS). Continue intensive communication program, including publication and distribution of booklets updated with most recent information.</p> <p>1999 - The Department of Energy's EMF program will be completed in FY 1998. No funding has been requested for FY 1999.</p>	\$7,906	\$6,893	\$0
TOTAL Electric and Magnetic Fields R&D	\$7,906	\$6,893	\$0

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

Climate Challenge	FY 1997	FY 1998	FY 1999
<p>1997 - Using prior year funds expanded participation to include a minimum of 650 electric utilities; report major utility accomplishments; summarize and publicize individual utility actions to stimulate replication; and contribute to a strong U. S. position during international Climate Change treaty negotiations.</p> <p>1998 - Using prior year funds, renegotiate existing agreements with individual utilities as required. Begin dialogue with electric utility industry to design a post-Kyoto voluntary program for “early credit” for the post-2000 period.</p> <p>1999 - Engage in dialogue with electric utility industry to design a voluntary program for the post-2000 period. Current program has agreements expiring in 2000. Then renegotiate individual agreements with utilities to include voluntary utility commitments in the post-2000 period. Continue to compile and report utility industry accomplishments; and continue to catalyze additional utility industry-wide climate change initiatives.</p>			
	\$0	\$0	\$500
TOTAL Climate Challenge	\$0	\$0	\$500
TOTAL Electric Energy Systems and Storage	\$31,378	\$42,788	\$38,500

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

High Temperature Superconductivity R&D:

Superconductivity Partnership Initiative (SPI): Reduces funding level of awards for new Phase I projects.

\$-200,000

SOLAR AND RENEWABLE ENERGY

ELECTRIC ENERGY SYSTEMS AND STORAGE (Cont'd)

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999 (Cont'd):

Second Generation Wire Initiative: An increase of \$100,000 accelerates scale-up for Second Generation Wire processing. \$100,000

Strategic Research: An increase of \$95,000 increases activity in coil prototype development. \$95,000

Energy Storage R&D: The Storage 2000 initiative will develop multiple storage applications relevant to the restructured electricity marketplace. The applications include Renewable Generation and Storage (RGS), Peak Shaving, and Substation Storage systems. RGS systems applications will be developed as a cofunded joint effort with the photovoltaic program. Power System Reliability research will develop technologies to ensure grid reliability as forces under industry restructuring require operation of the power system in ways for which it was not designed. \$2,110,000

Electric and Magnetic Fields R&D: Program terminates in FY98 as scheduled. \$-6,893,000

Climate Change: FY 1998's reduced level of activities was supported by carryover funds. FY 1999 funds will support ongoing efforts to catalyze additional voluntary efforts by utilities to reduce greenhouse gas emissions, analyze and report on utility industry accomplishments, and engage utilities in a dialogue to design a post-2000 voluntary program. \$500,000

Total Funding Change, Electric Energy Systems and Storage **\$-4,288,000**

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY

(Tabular dollars in thousands, Narrative in whole dollars)

SOLAR AND RENEWABLE ENERGY PROGRAM DIRECTION

I. Mission Supporting Goals/Ongoing Responsibilities:

A. Program Description:

Program Direction provides the staffing resources and associated funding to support the management and oversight of the Solar and Renewable Energy Programs. This activity includes all funding for support service contractors, equipment, travel, crosscutting activities, and Assistant Secretary initiatives. This permits the continuation of a diverse array of Solar and Renewable projects to be integrated into a national portfolio of world renown research. Program Direction encompasses two principal activities: (1) Headquarters executive and program management; and (2) program operations at the Golden Field Office and the Idaho Operations Office.

Solar and Renewable Energy management is committed to reduce the costs for all administrative activities and achieve savings through a more streamlined and efficient management of federal staffing levels in this account. From the start of FY 1995 through the end of FY 1999, FTEs are projected to be reduced over 38% (62 FTEs), from an end-of-year (EOY) final, staffing "utilization" rate of 164 FTEs in FY 1994 to an EOY of 102 FTEs in FY 1999. A major reorganization was implemented in FY 1996 which realigned employee staffing to accomplish DOE Strategic Alignment goals and to streamline administrative activities consistent with the Government Performance and Results Act. Specifically, downsizing management operations has provided for the elimination of management layers and for an increased supervisory span of control. Before the reorganization, the employee to supervisor ratio was 7 to 1; now it is 11 to 1.

B. The following major activities are included in Program Direction:

- a. Salaries and benefits: Nearly 55% of the Program Direction funding is for salary and benefits for Federal employees at Headquarters and in the Field who manage and implement the Solar and Renewable Energy Programs.

SOLAR AND RENEWABLE ENERGY

PROGRAM DIRECTION (Cont'd)

I. Mission Supporting Goals/Ongoing Responsibilities:

- b. Travel: Approximately 2% of the Program Direction funding supports the travel of Federal staff to perform on-site reviews and inspections of Solar and Renewable Programs which are implemented through out the United States and to attend scientific professional meetings.
- c. Support services: Approximately 28% of the Program Direction funding is for support services.
- d. Other related expenses: A total of 15% of the Program Direction funding is requested for landlord functions (e.g., rent, utilities, telecommunications, supplies and materials) to permit the operation of the Golden Field Office.

II. Funding Table: PROGRAM DIRECTION - EE

	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustment	FY 1998 Current Appropriation	FY 1999 Budget Request
GOLDEN FIELD OFFICE					
Salary and Benefits	\$1,326	\$980	\$0	\$980	\$915
Travel	72	75	0	75	80
Support Services	447	464	0	464	852
Other Related Expenses	385	371	0	371	679
Total, Golden Field Office	\$2,230	\$1,890	\$0	\$1,890	\$2,526
Full Time Equivalents	24	17	0	17	15

SOLAR AND RENEWABLE ENERGY

PROGRAM DIRECTION (Cont'd)

II. Funding Table: PROGRAM DIRECTION - EE (Cont'd)

	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustment	FY 1998 Current Appropriation	FY 1999 Budget Request
IDAHO OPERATIONS OFFICE					
Salary and Benefits	\$85	\$176	\$0	\$176	\$181
Travel	14	3	0	3	5
Support Services	0	0	0	0	0
Other Related Expenses	0	0	0	0	0
Total, Idaho Operation office	\$99	\$179	\$0	\$179	\$186
Full Time Equivalents	1	2	0	2	2
HEADQUARTERS					
Salary and Benefits	\$8,864	\$8,750	\$0	\$8,750	\$8,320
Travel	267	320	0	320	335
Support Services	0	2,862	0	2,862	3,943
Other Related Expenses	1,592	1,650	0	1,650	1,690
Total, Headquarters	\$10,723	\$13,582	\$0	\$13,582	\$14,288
Full Time Equivalents	98	92	0	92	85
TOTAL PROGRAM DIRECTION					
Salary and Benefits	\$10,275	\$9,906	\$0	\$9,906	\$9,416
Travel	353	398	0	398	420
Support Services	447	3,326	0	3,326	4,795
Other Related Expenses	1,977	2,021	0	2,021	2,369
Total, Program Direction	\$13,052	\$15,651	\$0	\$15,651	\$17,000
Total Full Time Equivalents	123	111	0	111	102

III. Performance Summary:

SOLAR AND RENEWABLE ENERGY

PROGRAM DIRECTION - EE (Cont'd)

Program Direction - EE	FY 1997	FY 1998	FY 1999
<p>Salaries and Benefits: FY 1997, FY 1998, FY 1999 - The major reorganization implemented in FY 1996 to accomplish DOE Strategic Alignment goals has continued to help enhance streamlining activities which are consistent with the Government Performance and Results Act. The elimination of layers of management and third-tier organizations and the increase in supervisory span of control has resulted in cost savings for administrative activities in the Program Direction account. Through these initiatives, FTEs will have been reduced a total of 62 FTEs, or 38%, over the 5 year period ending in FY 1999. Operational efficiencies will continue to be identified and implemented leading to greater savings in the future</p>	\$10,275	\$9,906	\$9,416
<p>Travel: FY 1997, FY 1998, FY 1999 - Travel has been substantially reduced from previous years through the use of teleconferencing facilities for the conduct of oversight activities of some field organizations. The escalation of travel costs preclude further reductions without impacting EE's ability to achieve its missions requirements. The nominal increase in FY 1999 is requested to offset the estimated inflation in travel costs.</p>	\$353	\$398	\$420

SOLAR AND RENEWABLE ENERGY

PROGRAM DIRECTION - EE (Cont'd)

Program Direction - EE (Cont'd)	FY 1997	FY 1998	FY 1999
Support Services: FY 1997, FY 1998, FY 1999 - Includes all funding for support service contractors, equipment, crosscutting activities, and Assistant Secretary initiatives. Such activities include the development and evaluation of performance measurement and quality metrics for the Solar and Renewable Energy Programs. These activities are expected to achieve efficiency savings throughout the programs, and return to the taxpayer program cost savings far in excess of the expenditure. The support, will enable adoption of sound business practices called forth under the Government Performance and Results Act (GPRA) of 1993 and the Government Management Reform (GMRA) Act of 1994. Other support services include activities such as mailroom, travel processing, computer systems development and hardware and software installation, configuration, and maintenance activities. The \$447,000 for support services in FY 1997 was for landlord activities for the Golden Field Office. An additional \$3,397,000 in support services at headquarters was funded in the R&D programs that used the services in FY 1997. FY 1998 and FY 1999 funding will provide for the continuity of the most critical support service activities.	\$447 ¹	\$3,326	\$4,795

¹ The \$447,000 was for support services at the Golden Field Office. An additional \$3,397,000 for support services was funded in FY 1997 in the R&D programs. Thus, the FY 1997 total funding for support services was \$3,844,000.

SOLAR AND RENEWABLE ENERGY

PROGRAM DIRECTION - EE (Cont'd)

Program Direction - EE (Cont'd)	FY 1997	FY 1998	FY 1999
Other Related Expenses: FY 1997, FY 1998, FY 1999 - This activity includes the Working Capital Fund (WCF) and contractual services associated with landlord support of the Golden Field Office. Funding for the WCF in FY 1997 through FY 1999 is \$1,374,000; \$1,650,000; and \$1,690,000, respectively. Rent is the largest component of the Working Capital Fund (FY 1997 through FY 1999 is \$468,000; \$596,000; and \$600,000, respectively). The balance of the Other Related Expenses is for Golden landlord requirements such as rental payments to GSA, expendable office supplies and materials, telecommunications and utilities, training, purchase of goods and services from Government accounts, printing and graphics, postage, maintenance and service agreements, and publications. The total costs for the Golden Office are split between the Energy Supply Appropriation and the Interior and Related Agencies Appropriation.			
	\$1,977	\$2,021	\$2,369
Total Budget Authority, Program Direction	\$13,052	\$15,651	\$17,000

IV. EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Decrease of \$490,000 in Salaries and Benefits is due to Golden Field Office and Headquarters FTE reductions.	\$-490,000
Increase of \$22,000 in Travel is for inflationary adjustments in airfare and per diem costs.	\$22,000
Increase of \$1,469,000 in Support Services reflects all funding for support service contractors, equipment, crosscutting activities, and Assistant Secretary initiatives.	\$1,469,000
Increase of \$348,000 in Other Related Expenses is for primarily landlord costs at the Golden Field Office and inflationary costs for the Working Capital Fund (primarily for rent).	\$348,000
Total	\$1,349,000

Support Services	FY 1997 (\$000)	FY 1998 (\$000)	FY 1999 (\$000)	FY 1999/FY 1998 Change (\$000)
Technical Support Service				

Feasibility of Design Considerations	\$0	\$0	\$0	\$0
Economic and Environmental Analysis	1,685	1,460	2,100	640
Test and Evaluation Studies	0	0	0	0
Subtotal	\$1,685	\$1,460	\$2,100	\$640
Management Support Services				
Management Studies	1,660	1,439	2,080	641
Training and Education	0	0	0	0
ADP Support	499	427	615	188
Subtotal	\$2,159	\$1,866	\$2,695	\$829
Use of Prior-Year Balances	0	0	0	0
Total Support Services	\$3,844 /a	\$3,326 /b	\$4,795 /b	\$1,469

Other Related Expenses	FY 1997 (\$000)	FY 1998 (\$000)	FY 1999 (\$000)	FY 1999/FY 1998 Change (\$000)
Training	\$18	\$20	\$25	\$5
Working Capital Fund	1,374	1,650	1,690	40
Printing and reproduction	3	3	6	3
Rental Space	215	222	229	7
Software Procurement/Maintenance	30	36	56	20
Other	337	90	363	273
Subtotal	0	0	0	0
Use of Prior Year Balances	0	0	0	0
Total Other Related Expenses	\$1,977	\$2,021	\$2,369	\$348

- /a Includes \$447, 000 in FY 1997 support services at the Golden Field Office \$3,397,000 which was funded in the R&D programs that used the support services.
- /b Includes all funding for support service contractors, equipment, crosscutting activities, and Assistant Secretary initiatives.

SOLAR AND RENEWABLE RESOURCE TECHNOLOGIES

FEDERAL BUILDINGS/REMOTE POWER INITIATIVES

(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives: The Federal Buildings/Remote Power Initiative will identify, facilitate and document the economic benefit of using renewable energy technologies in applications that are currently cost-effective in the marketplace. The Initiative will demonstrate that renewable energy technologies are cost competitive, reliable, an easy to operate an maintain by funding projects that have verifiable, favorable cost benefits over a period of not more than ten years.

The Federal building portion of the initiative will provide financial cost sharing assistance to Federal agencies that are developing renewable energy technologies, such as win envelopment on San Clemente Island, California, solar domestic hot water collectors in Pearl Harbor, Hawaii; an geothermal gradient technologies at the Naval support facility in Diego Garcia. The Remote power portion of the initiative works to deploy solar, win fuel cell, an biomass technologies in remote areas of the United States, and to develop an demonstrate their cost competitiveness compared to diesel generators. For example, modern fuel cell technology can replace diesel engines currently being used for snow production in Vermont.

II. Funding Schedule:

<u>Program Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>\$ Change</u>	<u>% Change</u>
Federal Buildings/Remote Power Initiatives	<u>\$ 0</u>	<u>\$ 4,924</u>	<u>\$ 0</u>	<u>\$ -4,924</u>	<u>-100%</u>
Total, Federal Buildings/Remote Power Initiatives	<u>\$ 0</u>	<u>\$ 4,924</u>	<u>\$ 0</u>	<u>\$ -4,924</u>	<u>-100%</u>

SOLAR AND RENEWABLE RESOURCE TECHNOLOGIES
FEDERAL BUILDINGS/REMOTE POWER INITIATIVES (Cont'd)

III. Performance Summary - Accomplishments:

Federal Buildings/Remote Power Initiatives	FY 1997	FY 1998	FY 1999
Federal Buildings/Remote Power Initiatives: 1997 - No funding provided. 1998 - Use financial incentives with the federal agencies at a maximum 20% cost share to leverage as much as \$5 million in installed cost-effective projects. Provide technical assistance to build infrastructure for future purchases of solar energy. Prepare a report to Congress on the progress of implementing solar energy technologies in Federal agencies as directed by Executive Order 12902. Identify and fund 12 or more leveraged remote applications of solar and renewable energy to reduce or avoid diesel and gasoline power generation. 1999 - No funding requested.			
	\$0	\$4,924	\$0
TOTAL Federal Buildings/Remote Power Initiatives	\$0	\$4,924	\$0

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Federal Buildings/Remote Power Initiatives: Funding for the initiative activities provided in FY 1998. No funding requested in FY 1999.

\$-4,924

Total Funding Change, Federal Buildings/Remote Power Initiatives

\$-4,924